The Dock & Harbour Authority

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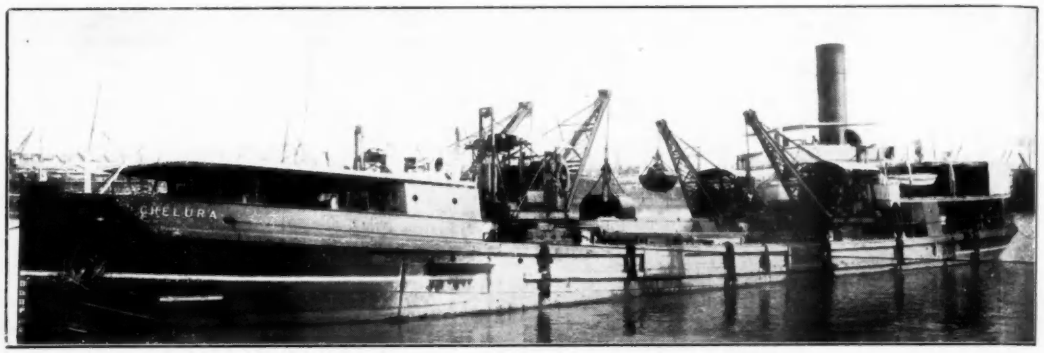
34-year-old "Priestman" is still the largest Grab-hopper Dredger in service

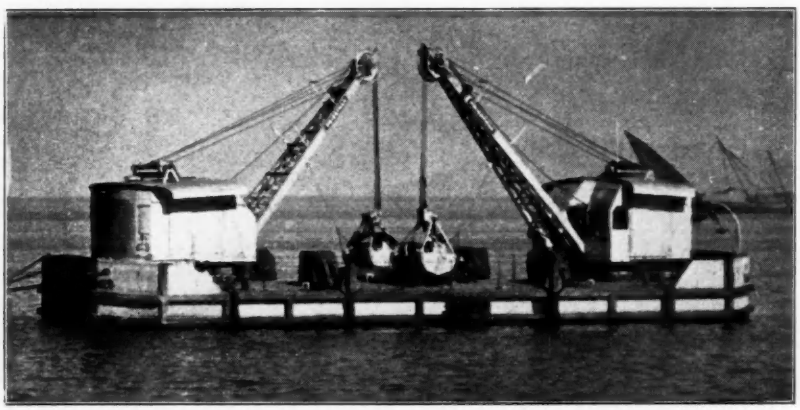
Bombay Port Trust specify "Priestman" on new Dredger



Thirty-four years may not, by comparison with the records of some venerable dredgers, be an exceptional life-span, but it is unusual in these days for the "world's largest" of anything to remain so for so long a period.

This is the record of the grab - hopper dredger "Chelura," fitted with four Priestman 3 - yard capacity grab dredging cranes, and owned by the Bombay Port Trust. After thirty-four years of monsoons, tropical heat, and all the difficulties which normally attend these conditions; the "Chelura" is not only still the "world's largest," but is every bit as efficient as she was in 1922.

After such a demonstration of reliability, it is hardly to be wondered that Priestman dredging cranes were specified when the Port Trust decided to purchase a further grab dredger.



The pontoon type dredger "Mayur" was built by The Mazagon Dock Ltd. at Bombay and has dimensions as follows:

Length	...	...	...	75-ft. 0-in.
Breadth	...	...	...	30-ft. 0-in.
Depth	...	...	...	8-ft. 0-in.
Draft	...	...	...	4-ft. 9-in.

It is arranged with a Priestman 2 cu. yd. dredging crane at each end with the necessary fuel and water tanks below decks amidships. Four winches for manoeuvring purposes are placed on deck amidships. In order to avoid damage to or from barges laid alongside the vessel is fitted with heavy fenders at deck and water level.

The two Diesel driven dredging cranes are of the Priestman No. 40 size, each arranged to operate with a total load of grab and contents of 4.4 tons at a maximum radius of 28-ft. from a jib of 31-ft. centres. The ropes are sufficiently long to allow the 2 cu. yd. grabs to be operated at a depth of 60-ft. below deck level.

The crane mechanism consists of separate power-operated drums on independent shafts and incorporates all those special Priestman features developed by their makers which have contributed so much to the successful operation of grab dredging equipment.

The Diesel engines develop 75 brake horse-power at 1200 revolutions per minute and are fitted with fluid couplings together with special oil coolers.

The mechanism and driver's platform are covered with a well-built steel house with large opening windows and shutters and a double roof with wide overhanging eaves. The driver thus has the maximum amount of protection from the elements and is not expected to sit in a partly exposed position under a sunshade roof.

The elimination of fatigue by well-designed controls and the provision of a comfortable driving seat leads to greater output per man-hour.

The dredger is for use in the docks at Bombay, where the spoil will be discharged into barges alongside and then towed out to be dumped in open water.

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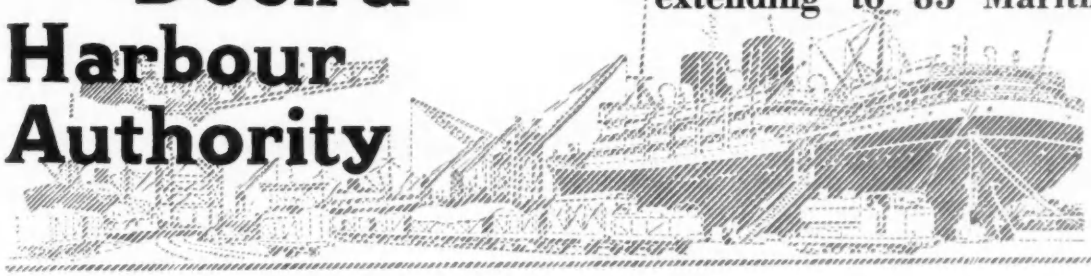

No. 435

Vol. XXXVII

JANUARY, 1957

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Editorial Comments

New Slipway for River Thames.

Our leading article this month spotlights a significant change that has taken place in the industrial activities of the River Thames.

For centuries past the Thames has been one of the main shipbuilding centres of England. Along the foreshores, in the inlets and creeks, can still be seen the remains of old grid irons and draw docks that gave this country its reputation as a seafaring nation. However, sail gave way to steam and ships came to be constructed in steel, so the shipbuilders looked for sites situated closer to the iron works and coalfields of the industrial Midlands. Thus it was after the turn of the century that shipbuilding firms began to move North. Many dry docks were filled in and are now used as wharves. Others have been adapted to purposes more suited to the heavy barge and small craft traffic of the River.

Union Dock in Millwall, one of the few remaining dry docks on the Thames, and the last of the three Fletcher Dry Docks, has now been converted to a slipway for the repair and maintenance of tugs and barges. By making use of the existing structure the conversion has been carried out at an economical cost by modern standards, and a noticeable feature of the new slipway is the overhead covering and concrete decking that enable the men to work on the craft with a very reasonable standard of comfort.

Here then, is an interesting example of the modification to modern requirements and conditions of labour of existing facilities which could no longer be economically employed.

Proposed Surge Dam for the River Thames.

In past issues mention has been made in these columns to the problem of protecting London from flooding, and as far back as December, 1953, the need was stressed for some type of barrage, which would not obstruct shipping or the natural ebb and flow of the River, but which would check abnormal flow sufficiently to prevent the serious effects of a surge.

In June, 1954, we commented on the final report issued by the Waverley Committee on Coastal Flooding, which laid emphasis on the protection of London, large areas of which are particularly vulnerable. This report suggested that another examination should be made into the possibility of building a barrage structure across the Thames at Purfleet, which could be closed on the advent of a surge. It was recognised that this scheme involved "formidable engineering and financial considerations," but it was the opinion of the Committee that such an investigation should be made. Experiments had already been carried out on the Port of London Authority tidal model of the Thames, following proposals put forward by the London County Council, that, if four hours before the arrival of the peak of the tide-cum-surge, barrage gates were lowered gradually into the river until an opening of only 10 per cent. of the sectional area of the river remained, the maximum water levels at London Bridge would be reduced by about 5-ft. without any increase in water levels downstream. The waterway would be kept clear except in times of impending high-flood.

This view, that a tidal wave accompanied by storm could be contained by a surge dam, was endorsed early last year by the Government's Thames Technical Committee. Now it has been announced that experiments will start this month on a proposed surge dam, which, if built, would cost about £15 million. The Minister of Housing and Local Government has instructed two firms of consulting engineers to investigate the practicability of constructing a barrage and to prepare designs in the light of their investigations. When this arrangement was made, it was realised that the consultants would probably require further model investigations to be carried out and prior agreement was reached with Sir Claude Inglis, Director of the Hydraulics Research Station at Wallingford, that he would conduct tests on models to be built at Wallingford or on the existing models in the Port of London Authority's laboratory at Victoria Dock.

In general, it is proposed to test the effects which the barrage would have on tidal levels in the two tidal models at Victoria Dock. These tests should not take very long to complete. The more lengthy and extensive investigations will be carried out on large-scale models at Wallingford to study the hydraulic characteristics of various types of barrage structure in which the consultants are interested; and, subsequently, to draw up a detailed method of operating the barrage under a variety of storm surge conditions.

It has been stated by London engineering experts that there appears to be no alternative solution to the flooding problem, except to raise costly embankments which would take many years to construct and would interfere with so many existing facilities as to make the plan impracticable. The London County Council, therefore, have decided to wait for the Government's decision on a surge dam. In view of the urgent need to formulate some definite plan, it is encouraging to learn of the projected experiments and it is to be hoped that the tests will be effective in deciding a practicable design.

The Problem of Dock Labour.

The problem of dock labour is an international one. It is repeatedly discussed and examined in maritime countries, where solutions of various types have been tried or sought. It has also been the subject of study by many international organisations, including, of course, the International Labour Organisation. The core of the problem is now considered to be decasualisation — a problem in itself, resulting from an inherent element in the work of the port industry, viz. intermittency.

Since the volume of port operating work can vary so much from day to day — often without warning — labour requirements vary similarly. Thus, in any major port it is essential to pay suitable attention to the needs of large numbers of bona fide dock labourers who will not be called upon for work every day. Sometimes, indeed, they may not be needed for several days on end.

An article by "Onlooker" in the October issue of this journal and this year's presidential address to the Institute of Transport by Mr. Francis H. Cave (reported in our November issue) were both pertinent contributions to the recent discussion of the above-mentioned subject, initiated in June last by the publication of the Devlin Report on the operation of the National Dock Labour Scheme. Mr. Cave gave as his subject "The State of the Ports" and suggested that the solution to the problem lies mainly in finding a satisfactory employer-employee relationship. This opinion is not universally held, naturally, and the point of view of the

Editorial Comments—continued

Unions is given in an article in the "International Transport Workers' Federation" Journal of November, 1956.

The title of the article is "The British Dock Labour Scheme Enquiry: A resounding Union victory." After outlining the events which preceded the introduction of the Dock Workers' (Regulation of Employment) Scheme of 1947, the article goes on to quote some present-day facts. For practical purposes, the Scheme may be considered as embracing all British ports covering some 81,000 dockers in 25 ports or groups of ports, the largest being London with 31,000 men, followed by Liverpool with over 18,000. Under the Scheme are registered over 1,200 employers of dock labour, ranging from port authorities such as that in London, employing an average of 6,000 men, down to the smallest wharfinger employing not more than two or three. Many of the employers are primarily concerned with trade other than dock work—they are coal merchants and warehousekeepers, for example—and some are only involved in the loading or unloading of their own ships.

The article admits that "under the Scheme the employers lost their right to control dock labour—or rather, to leave it uncontrolled—lost their power to discipline the docker and lost exclusive control of the industry. Instead, they had to work with trade union representatives on bodies exercising administrative functions which had previously been theirs alone. The employers' function was now defined as 'operational,' that is, the execution of their business, with labour provided for them."

Under the sub-heading "The employers and human relationship," the article states: "The Devlin committee demolished much of the employers' case systematically and ruthlessly. Proposal after proposal was taken, examined from ethical, logical and practical standpoints and discarded—often with barely concealed scorn. For example, the employers made much of their contention that the dual nature of the Board prevented the worker from knowing his employer and hence impeded the creation of human relationships between them. Did the docker know his employer, anyway? the Committee asked. Only twenty-one per cent. of them were on a weekly basis and the rest had never, even before the Scheme, had a regular employer whom they could get to know."

It is not clear upon what evidence this statement is based, but it is certainly true to say that in the pre-Scheme days, in all the years between the wars, many berths were manned by substantially the same casual labour, ship after ship. Such berths, wharves or departments usually had a preference scheme and the men belonging to it were even, at some places, taken on in strict rotation according to the number of the preference ticket they held. Even non-preference men went to the call stands at which they were known and there are still working in our ports many men who will be the first to agree that a very human relationship existed between them and the supervisory staff who organised and controlled the work. That much needed relationship was steadily growing in many places until it received its major setback with the introduction of the National Dock Labour Scheme, which made the casual dock labourer, at least, feel that his only employers were the Dock Labour Board and that he had no responsibility to the firm which engaged him for a day or a ship. This lack of sense of responsibility, already so rife in post-war days, has been much accentuated in dockland (where it can be least afforded) by the operation of a Scheme which lacks something vital. The writer of the ITF article is correct when he says that under the Scheme the employers have lost their power to discipline dock workers. What he does not add is that experience has shown that the disciplinary procedure embodied in the Scheme is not effective and that port work is suffering seriously because of this.

In previous issues of the ITF Journal have appeared articles on "The Hamburg Port Worker" (October, 1956) and "Dock Labour in Japan" (August/September, 1956). Both, of course, are written from the Union standpoint and thus express the considered opinion of only one side of the industry. They will, however, be of interest to all engaged in port operating work. We are therefore printing in this issue extracts from the former article, and in our February number will appear a summary of "Dock Labour in Japan."

Topical Notes

World Analysis of Time Lost Through Strikes.

According to an analysis prepared by the International Labour Organisation, more than 500 million man-days were lost through work stoppages in 28 different countries over the past seven years. More than 75 million workers were involved.

The analysis indicates that though strikes and lock-outs were more numerous in 1955 than in 1954, the situation still compared favourably with most post-war years. The figures were arrived at by I.L.O. statisticians after examining available data from Argentina, Australia, Belgium, Burma, Canada, Ceylon, Chile, Denmark, Finland, France, Federal Republic of Germany, Hawaii, India, Ireland, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Pakistan, the Philippines, Puerto Rico, Sweden, Switzerland, the Union of South Africa, the United Kingdom and the United States.

They showed that total man-days lost through industrial disputes in these 28 countries dropped from 96.2 and 94.9 million in 1949 and 1950 respectively, to 51.9 million in 1951, rose again to 93.5 million in 1952, and then fell off to 61.3 and 49 million respectively in 1953 and 1954. The estimated total for 1955 was 60,200,000 man-days

The most striking feature was the impact of disputes in mining and quarrying: the rates of days lost in this industry were much higher than in any other industry and indicated that this branch was far more severely affected by disputes during the period covered—1949 to 1955—than any other.

There were no great differences between the rates of days lost in manufacturing, construction and transport and communications although more detailed information suggests that, of all transport workers, dock workers were the most prone to strike.

The survey goes on to state that within manufacturing the highest rate of days lost occurred in the metal trades, with the vehicle industry to the fore. The textile industry, the food, beverage and tobacco industries, as well as the other manufacturing industries taken together, showed lower rates of days lost per employee than manufacturing as a whole.

The number of days lost through work stoppages was only a very small percentage of the total number of man-days worked. It was seldom more than one day per worker per year and in many countries represented not more than one or two hours.

Move to Reduce Freight Rates.

The Organisation for European Economic Co-operation and the United States Government have taken steps which should have the effect of reducing current pressure on freight rates.

The present shortage of shipping has led to a considerable rise in freight rates in certain trades; this shortage is due partly to recent disturbances in the Middle East, longer voyages resulting from the closure of the Suez Canal, and partly to abnormal demands for United States coal and the concentration of shipments over a short period. Since the end of July, current freight rates have risen by 60 per cent. on European imports of United States coal and rates on oil from the Gulf of Mexico have almost trebled.

The O.E.E.C. Council has instructed these bodies of the Organisation responsible for coal and maritime transport to consider, as a matter of urgency, the possibilities of limiting importing countries' demands for dry bulk cargoes, spreading shipments over longer periods and placing orders for tonnage as far in advance as possible.

The United States intends to put a large number of ships from its reserve merchant fleet rapidly back into service; this will have the effect of increasing to a considerable extent the tonnage available for shipments to Europe. The United States Government has announced, through its Representative on the O.E.E.C. Council, that it is studying the possibility of releasing further vessels

As regards oil, the European supply position will be eased by the co-operation which has been established between the O.E.E.C. Petroleum Emergency Group, which is composed of the international oil supplying companies of Europe, and the Middle East Emergency Committee which includes the principal American companies exporting to Europe.

The Conversion of a Dry Dock to a Slipway

For the Repair of Tugs and Barges on the River Thames

By C. BRAND, B.Sc.(Eng.), A.M.I.C.E.,
and
A. G. TATE, B.Sc.(Eng.), A.M.I.C.E., A.M.I.Struct.E.

DUE to the gradual exodus of the shipbuilding industry from the River Thames to the Northern Ports that has taken place over the last thirty years, Union Dry Dock, in Millwall, fell into disuse after the Second World War. It was purchased by the General Lighterage (Holdings) Group whose Chairman is Mr. P. S. Henman, M.Inst.T., early in 1954 for conversion to a Slipway for the repair and maintenance of their large fleet of tugs and barges, which had outgrown the facilities available at their Charlton Depot.

The history of the early development of the site is of interest. The original site had been a breach in the river bank (referred to in Pepys's Diary) and the first Dock was built by the 17th century Shadwell shipbuilding firm of William Fletcher in 1818. It appears that considerable difficulty was experienced in driving piles in the Dock bottom, and the resourceful Joseph Fletcher devised an ingenious method of overcoming this obstacle. An old East Indiaman, a ship named the "Canton," was purchased and brought to Limehouse where she was stripped and sunk into the excavations made for the new Dry Dock, after the removal of her bow and stern. Gates were fitted and a fine oak-lined Dry Dock was formed.

How the problem of buoyancy was overcome is not clear from the records available, but it is known that the "Canton" served a useful purpose as a Graving Dock for 65 years. Its life was terminated only because it could not accommodate the larger vessels that were required as the 19th century progressed.

A new Dock, 440-ft. in length, was constructed in 1898, and this Dock, which berthed many famous ships such as the "Cutty Sark," is the one that has been converted into a Slipway.

Design.

The general condition of the Dry Dock walls was good, although vertical cracks had formed in one section due to bomb damage in the vicinity during the last war. It was therefore decided to make good the cracks in the sides of the Dock, and use them as the retaining walls for the sides of the new Slipway. It was also decided to make use of the existing Dock floor, which was known to be heavily piled, to support the Slipway rail beams and the stanchions to the overhead covering.

A plan of the Dry Dock is shown in Fig. 1, and it will be seen that the Dock was sufficiently wide at the entrance to form a double Slipway, and its length was adequate to provide room for raising the Slipway at a reasonable gradient of 1 in 16 with sufficient room for a plating shop at ground level, at the inshore end. It was necessary to set the front wall of the plating shop back from the boundary wall, in order that no encroachment will be made if the proposed widening of West Ferry Road is carried out at some future date as part of the London County Council's plans for the development of the area.

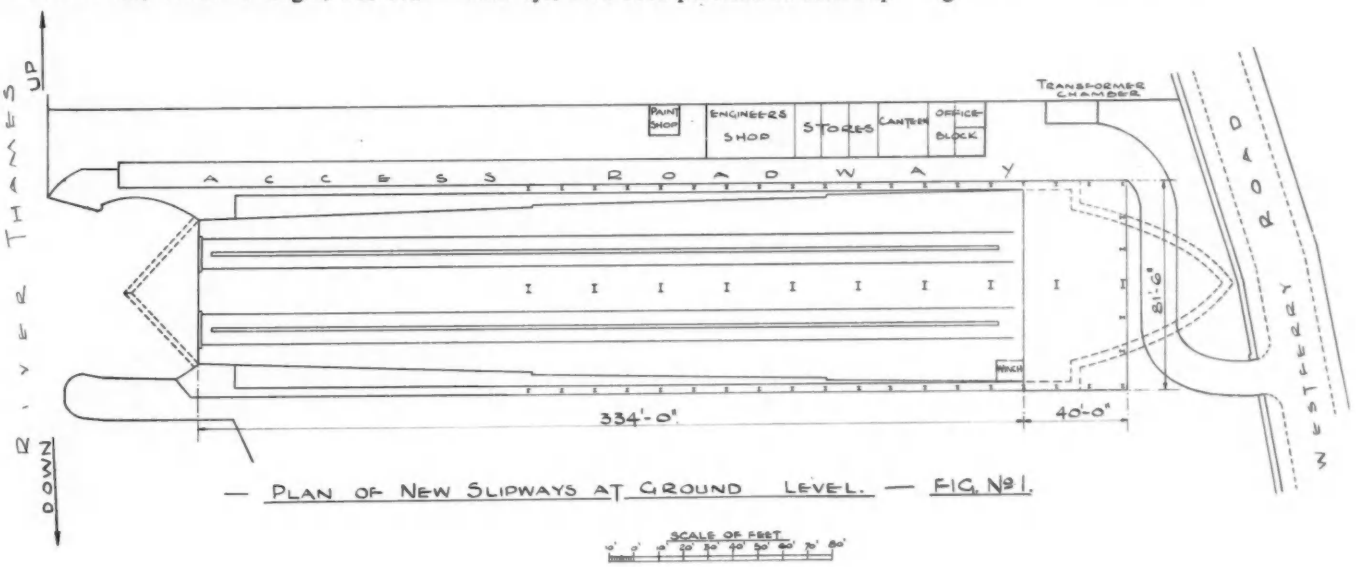
The steel framework of the plating shop has been extended for a length of 200-ft. over the Slipway in order that the men employed on the site can work under cover. Gantry cranes, electrically operated from the walkways, have been provided to each Slipway, and these run on rails supported on brackets attached to the side and centre stanchions for the full length of the plating shop and overhead covering. As these cranes traverse the full width of each Slipway, complete crane coverage is provided within the area of the steel framework.

The head of water over the sill at mean neap tides is sufficient to provide access to the Slipway for small tugs and barges on any tide. As approximately 80-ft. of the Slipway is above water level on mean spring tides, work involving the removal of plates below the water line can be carried out on two craft simultaneously, whilst minor or deck repairs can be carried out to a further four craft lower down the Slipway.

At the top of each slipway the headroom is sufficient to accommodate a vessel 15-ft. in height, 120-ft. in length, with a beam of 24-ft. and unladen weight of 100 tons.

Each Slipway is furnished with a cast steel ratchet placed flush with the concrete and centrally between each pair of rails. Pawls fitted to the cradles engage with the ratchets to provide a safeguard against failure of the hauling mechanism.

The hauling mechanism consists of a 15 ton double drum petrol driven winch set to one side of the Slipway in such a position that the operator has an unrestricted view of both Slipways. Each drum is controlled independently and separate bonds are provided for each Slipway. Anchorages have been placed at the head of each track and the majority of craft using the upstream berth can be hauled directly through a snatch block shackled to the upper anchorage.



— PLAN OF NEW SLIPWAYS AT GROUND LEVEL. — FIG. No 1.

SCALE OF FEET

The Conversion of a Dry Dock to a Slipway—continued.

View of existing drydock from inshore end after removal of mud and silt.

Dock gates being demolished.

When a double haul is required on this set of rails, an additional anchorage set off centre at the top of the upstream Slipway is used. This anchorage is also used in conjunction with the anchorage at the head of the lower Slipway for hauling craft up the downstream berth for single or double hauls, as the short lead from the drum of the winch to the lower anchorage would cause the bond to lie unevenly on the drum and would result in excessive wear of the wire rope.

Details of this hauling system are shown in Fig. 2.

Two cradles have been provided for each Slipway of an unusual design. Rather than have carriages with a short wheelbase that might tend to rack, with consequent heavy maintenance costs on wheels and hauling ropes, etc., it was decided to construct rigid steel framed cradles with a relatively long wheelbase, each having six cast steel wheels. The cradles are decked with timbers and provided with shores to suit the requirements of the vessels landing on them. They have proved very successful in practice, no racking taking place and berthing is a quick and simple procedure.

At the head of the Slipway, on the upstream side, two static compressors have been placed with air lines running across the Slipway and down both sides. A well equipped plating shop is situated above the Slipway and fitted with double sliding doors on either side for the access of lorries. Two walkways lead off the plating shop on either side of the Slipway from which berthing and the overhead cranes can be controlled.

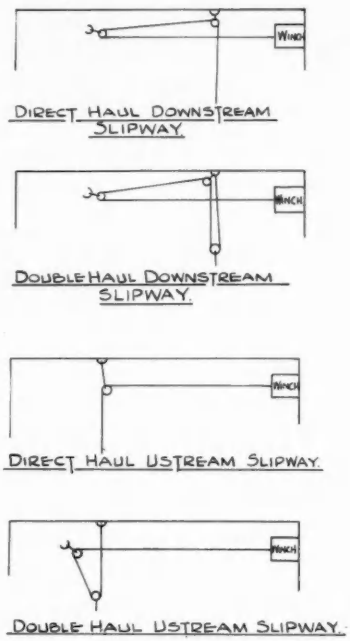


FIG. No. 2.

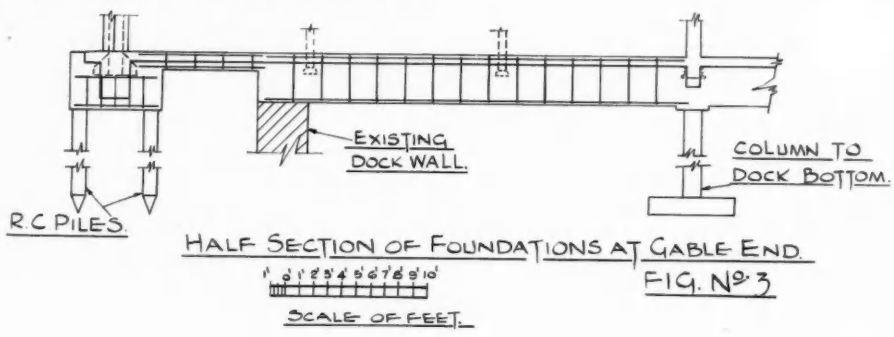
An electrical sub-station, offices, a canteen, stores lavatories and an engineering shop have been built on the upstream side of the Slipway adjacent to a concrete roadway running along the full length of it.

In order to make full use of the existing Dock, the design of the foundations to the steel framed structure was unconventional. The width of the Dock at the head narrowed abruptly and curved to a point, crossing under the gable end of the plating shop. It was therefore possible to make use of the walls to support the ground beams in two directions. Reinforced concrete piled foundations were provided at each corner of the plating shop and the gable end stanchions were supported by reinforced concrete ground beams founded on the piles, the existing Dock wall and a column constructed from the Dock bottom, as shown in Fig. 3.

As a measure of economy, the height of the roof trusses was limited to give the minimum clearance for the gantry cranes, and the structure at eaves level was considered, for design purposes, to be pin jointed. The whole of the bending moment due to wind pressure on the sides of the building was therefore transmitted to the base through the side stanchions, where a rigid foot, in the form of a grillage, induced a considerable moment on to the Dock walls.

With the penultimate side stanchions at the inshore end of the plating shop, it was possible to distribute the moment through a reinforced concrete beam to the Dock walls approximately 10-ft. from the centre line of the stanchions. In the case of the side stanchions, the problem was not so easily overcome as they bore directly upon the Dock Walls.

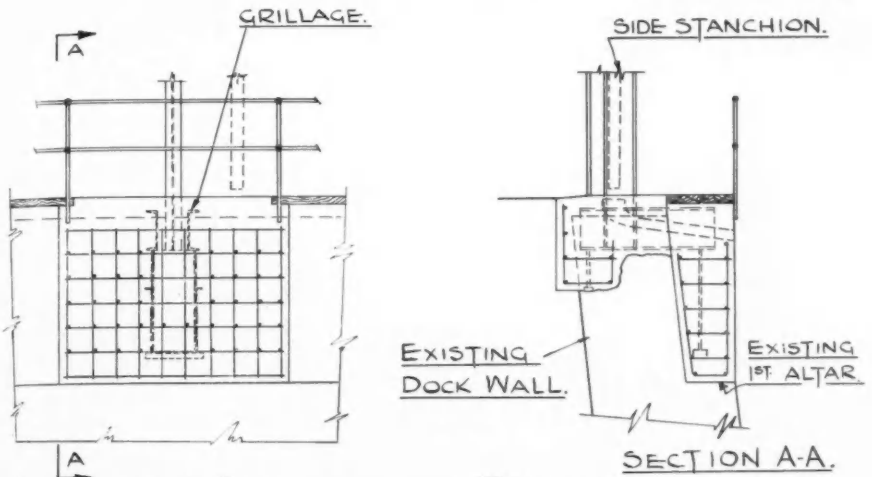
Trial excavations had shown that the rear face of the Dock wall ran parallel with the



HALF SECTION OF FOUNDATIONS AT GABLE END.

FIG. No. 3

The Conversion of a Dry Dock to a Slipway—*continued.*



SECTIONAL ELEVATION OF TYPICAL SIDE STANCHION BASE. FIG. Nº 4.

front face, and the reverse moment had therefore to be transmitted to a footing spread along the wall to give a low bearing pressure. On the inside face of the wall it was decided to construct footings from the first altar that would not only provide satisfactory bases to the side stanchions but would also serve as a very convenient form of walkway to which the handrail standards could be fitted. Gaps were left, approximately 6-ft. wide, that were spanned by timbers bolted to the concrete. A section of a typical base is shown in Fig. 4.

The centre stanchions of the steel framed structure and also the beams carrying the Slipway rails, were supported by reinforced concrete columns founded on spread footings. These footings were designed to produce a maximum bearing pressure on the concrete Dock floor of 4 tons per square foot under combined dead and live loading.

Details of the arrangement of the rail beams and columns are shown in Fig. 5.

The rail beams were designed for continuity over five spans to support a maximum loading spread over two cradles of 100 tons. Flat bottomed rails were set flush with the top of the concrete with bulb angle check rails on either side. A system of tie beams was constructed at ground level connecting the rail beams with the Dock sides and the centre stanchion bases.

The surface of the Slipway and plating shop was covered with concrete 9-in. thick, reinforced with high tensile twisted steel fabric. This concrete slabbing bore directly on to a mixture of hardcore and excavated material and was designed for a maximum bearing pressure of 0.25 ton per square foot.

At the outriver end of the Slipway a reinforced concrete retaining wall 5-ft. deep was constructed on top of the old Dock sill. Four cast iron drain pipes fitted with tidal flaps on the outer face and perforated steel covers and graded filters on the interior face, were built into the wall, as it was not possible to eliminate the passage of land water through the existing Dock sides below the level of the Slipway. The graded filters consisted of brick hardcore at the pipe entrances reduced to a fine sand in successive layers. By this method it is hoped to prevent the passage of any solid matter through the drains with the consequent formation of voids beneath the concrete.

The anchorages to the hauling mechanism consisted of U bolts built into reinforced concrete beams bearing directly down the line of the rail beams. A substantial reinforced concrete base was formed to the winch and the concrete between the winch and the opposite side of the Dock was deepened and strengthened with additional reinforcement.

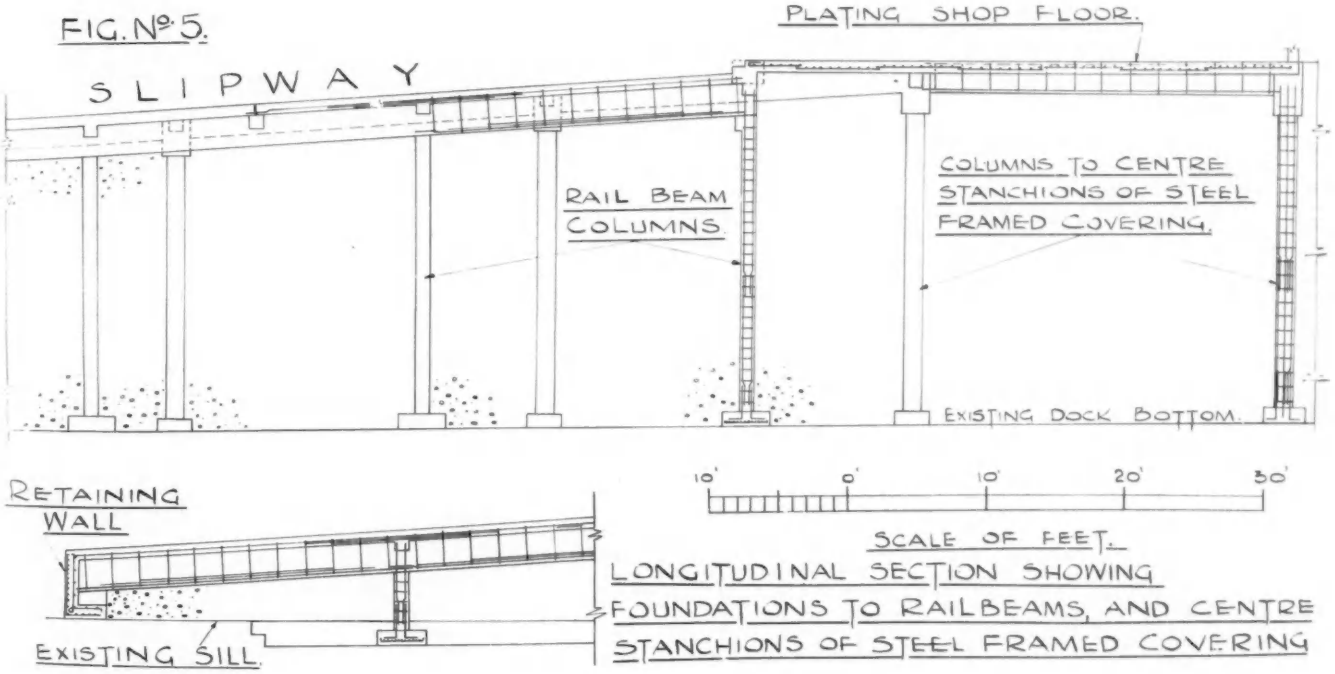
Construction.

Before constructional work could be commenced, an accumulation of mud, of which there was approximately 4,000 cubic yards, had to be removed from the Dock. The existing Dock gates leaked badly and this mud had gradually seeped in from the river through gaps in the mitre faces.

Attempts were made to wash the mud through the sluices on the ebb tide by agitation with compressed air, but only a limited amount in the vicinity of the gates could be cleared in this fashion. A large belt of stiff mud would not respond to this treatment.

The stiff mud was removed by dragline operating from the dock side, and, by means of a fire pump and hoses, the remaining mud

FIG. Nº 5.



LONGITUDINAL SECTION SHOWING FOUNDATIONS TO RAILBEAMS, AND CENTRE STANCHIONS OF STEEL FRAMED COVERING

The Conversion of a Dry Dock to a Slipway—continued.

Construction of retaining wall at outriver end of dock.

View from inshore end—slipway nearing completion.

was agitated into a slurry and washed down the dock for disposal by a heavy sludge pump.

The Dock gates were then reinforced in weak spots and carefully caulked so that the construction of the foundations on the Dock bottom could be carried out, under dry conditions. Accumulations of land water and occasional minor leaks that occurred in the gates from time to time were satisfactorily dealt with by a large centrifugal pump at the lower end of the Dock.

The construction of the retaining wall, footings and first lift of the columns was carried out before the filling of the Dock could commence. This latter operation, involving approximately 20,000 cubic yards of material had to be very carefully co-ordinated with the building programme in order to ensure an adequate rate of fill, and at the same time proper consolidation. As the filling proceeded the next lifts of the columns could be carried out using the newly placed filling material as a working platform.

A bulldozer was in constant attendance levelling and spreading the filling as it was deposited, At times, particularly during the construction of the rail beams, considerable congestion was experienced, and great care had to be taken to avoid damage to the newly completed work.

After all the filling had been placed, a 10 ton diesel roller was continually run up and down the lanes between the rail beams to complete the consolidation of the filling.

The tie beams, concrete slabbing and the laying of the rails was next carried out progressively from the lower end of the Dock, with expansion joints at 60-ft. intervals. At the same time work was well advanced on the construction of the side stanchion bases and ground beams supporting the steel framed structure.

The erection of the steelwork was commenced at the inshore end and did not interrupt the work in progress on the Slipway. This work was of a conventional nature and does not call for any special description.

Alongside the Dock, in the later stages, the construction of the general buildings was under way, and it is worthy of note that remarkably few delays occurred due to the presence of three contractors who were all operating at the same time on a somewhat congested site.

Some difficulty was experienced in demolishing the Dock gates. The bottom 3-ft. of gates were filled with concrete and due to the accumulation of mud outside the Dock it was not possible to break up this concrete. Consequently a Port of London Authority floating heavy lifter had to be employed to remove the bottom sections.

The constructional work commenced in June, 1955, and was completed in October, 1956, although the Slipway was in use by the end of August, 1956.

The Main Contractors employed on the site were G. Tate and Son Ltd., who were also responsible for the design of the project. The Sub Contractors for the steelwork were Brown and Tawse Ltd., for the general office block, Slade Betts; for the filling, John Harris (Bermondsey) Ltd., and for the removal of the Dock gates, Thos. W. Ward Ltd.

The completed Slipway is certainly one of the most modern of its kind on the River Thames. It is being operated by the Thames Dry Dock and Engineering Co. Ltd., for the building and repairing of small craft, motor vessels, tugs and barges, and also for other engineering work.

It was opened officially on the 7th November, 1956, by Admiral Sir William Andrewes, K.B.E., C.B., D.S.O., M.I.E.E.

Coal Bunkering Plant at Aberdeen

As the third-largest fishing port in the country, Aberdeen handles 80 to 100 thousand tons of fish each season and the fleet of trawlers using the port require a speedy and efficient refuelling service. To meet the coal bunkering demands of these trawlers—which vary widely in size—a plant was designed and installed in 1948 by Mitchell Engineering Ltd. for Aberdeen Harbour Commissioners under the direction of the Harbour Engineer, Mr. John Anderson, M.I.C.E. This plant can deal with up to four trawlers at once and feed coal at 50 to 150 tons an hour to each bunkering point.

Most of the coal used is shipped to Aberdeen from the Northumberland and Durham mines and is stored in a 4,500 ton compound at the quayside until needed. It is up to 15 cu. inches in size and breakage must be avoided as much as possible.

In designing the plant the following factors had to be considered:

(1) flexibility in operation

(2) accommodation for the largest and smallest trawlers

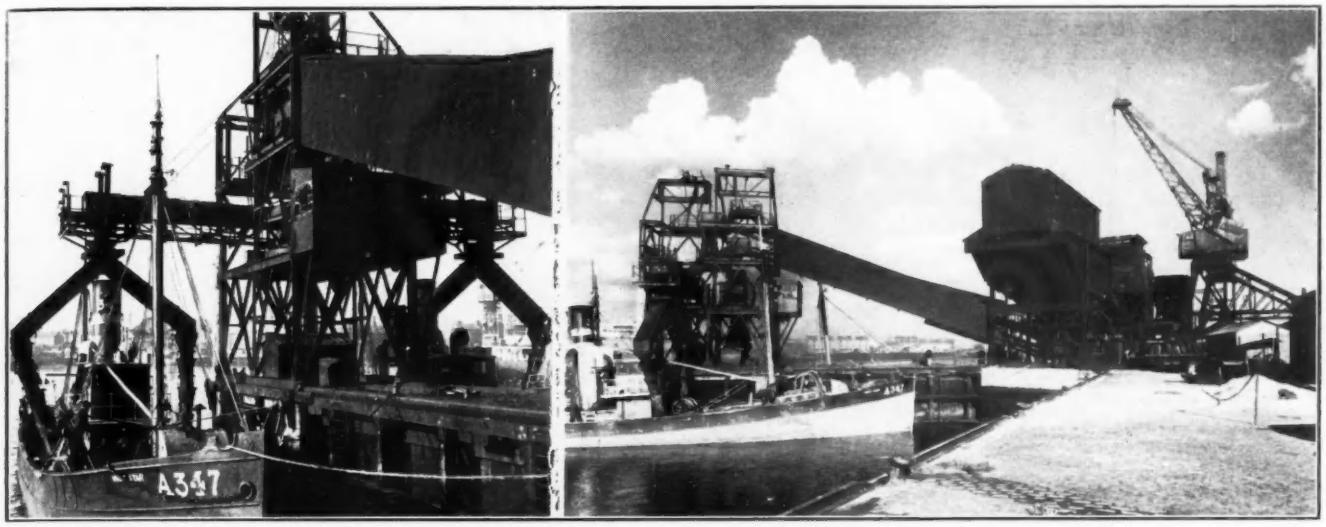
(3) a rise and fall in the tide varying as much as 13-ft.

To meet these conditions four loading-out points were installed —two on the main quay and one on either side of a jetty leading off from the main quay. Coal for these points is reclaimed from the stock by two 7-ton electric travelling cranes and is delivered to two 30-ton capacity receiving hoppers on the main quay, and one of 200 ton capacity at the jetty.

The coal is extracted from the hoppers by belt feeders to short, inclined belt conveyors which are fitted with automatic belt weighers and totalisers so that all the coal passing through the system may be accurately weighed.

From the conveyors the coal passes on to boom conveyors for the loading points on the quay and jetty. The boom conveyors

Coal Bunkering Plant at Aberdeen—continued



(Left). A trawler being fuelled at Aberdeen Harbour. The bifurcated chute attached to one of the boom loading conveyors can be seen in position. (Right). A general view of the plant.

are provided with luffing and slewing motions to allow the bifurcated chutes suspended at the ends of the conveyors to deliver to the bunkering hatches at all states of the tide.

The main belt conveyor runs alongside the quay and loads coal into the 200-ton two-compartment storage bunker at the quay end of the jetty for eventual delivery to the two loading points on the jetty itself. When vessels are being discharged at the quay, coal is deposited into the compound or quayside hoppers, the storage bunker for the jetty loading points being kept full by loading coal into two 5-ton capacity fixed hoppers straddling the main belt conveyor on the quay. These hoppers are fitted with reciprocating tray feeders.

The large storage bunker has three outlets—two for feeding the two jetty loading points and the other, for delivering coal to road vehicles.

Coal is fed from the storage bunker over two belt conveyors to the jetty loading points. Each of the conveyors is fitted with automatic weighers and totalisers and from the conveyors the coal passes on to the boom conveyors which can be luffed and slewed like those on the quay.

A bifurcated chute, fitted with a flap valve at the bifurcation point, is attached to all four boom loading conveyors. The chutes are designed to avoid blockage and to allow them to be moved freely by man-power about the vertical axis. These chutes straddle vessels across the bridge and do not interfere with any ships' fittings.

The vertical legs of the chutes consist of light steel tapering sections which fit loosely into each other and any number of them can be removed or added to cater for variations in the tide.

The plant is electrically-operated throughout.

Marine Pilotage

History, Development and Service

(Specially Contributed)

(Continued from page 266)

Maintenance.

In the early years of this century it was usual for a pilot to devise his own methods for making his services available to incoming vessels. This produced bold and resourceful seamen who designed their own boats to be capable of keeping the sea in all weathers with a minimum of man power. A type of fast sailing boat was evolved and keen, almost cut-throat competition developed between pilot and pilot. Whatever the reward for piloting a ship, the cost of maintaining the pilot's own boat was the first charge to be met as without a boat he could not pursue his calling. With the gradual disappearance of sailing ships and the need for greater speed these methods came to be recognised as wasteful in man-power and not always efficient and the individual operators gave way to an amalgamation of resources and men. Steam pilot vessels, accommodating a number of pilots cruised in appointed places where a pilot could most easily board under all conditions of weather. The pilots continued to own the boats and the pilots in each district formed a Private Company, each pilot holding shares, an arrangement which was combined with a pooling of the revenue from Pilotage Rates. After setting aside a sum for the maintenance of cutters, the remainder provided the pilots' earnings and such sums as were necessary for administrative purposes and pensions. Although the new system improved the efficiency of the service pilots were able to render it did fall somewhat harshly on the pilots at times, for the boats, crews and running expenses had to be provided in much the same state of readiness whatever the trade of the port might be. In times of slack trade or periods of depression in the shipping industry (fortunately somewhat remote to-day) there were times when there was little left for the pilots to share out amongst themselves as earnings, after the charges for maintenance had been met.

Each newly appointed pilot was expected to buy the shares of the retiring pilot, and depending on the capital of the Company, this might mean that a young man at the beginning of his career as a pilot would have to produce a substantial sum of money in order to take up his quota of shares in the Company.

Of recent years, the continuous burden of rising costs, particularly when a new pilot vessel is required, has proved to be too much for the pilots, and the Pilotage Authority has been obliged to take over the management and running of the pilot vessels. A function which the Authority has power under the Act of 1913 to perform, but one which in several cases it had been content to delegate to the pilots.

A change of management of this kind provides a convenient opportunity to review the Pilot Rate structure so as to make a clear cut distinction between the Revenue for maintenance of Pilot Vessels (payable to the Authority) and the Revenue for pilots' earnings, these Rates being referred to as Boat Rate and Pilot Rate respectively.

The establishment of a Boat Rate solely for the maintenance of pilot vessels raises an important issue as to which vessels should bear the cost of maintaining the service and the view seems now to be widely held that only those vessels which are actually served by

Marine Pilotage—continued

a pilot vessel should pay the Boat Rate. If a Liverpool pilot boards a vessel in London Docks bound for Liverpool it will not be necessary for such a vessel to stop outside the Mersey to pick up a pilot and the pilot steps ashore in Liverpool on arrival. In such a case no pilot vessel has been used, the pilot will be paid travelling expenses but the ship would appear to be not liable to pay Boat Rate.

The other side of the argument take the view that although the port itself is usually separately managed and administered—the pilotage service is one of the most important ancillary services in port operation and that the principle of exacting a payment from every ship entering the port towards the upkeep and maintenance of the pilotage service has much to commend it in adopting such a principle the cost of the upkeep of the service and the running of the cutters would be borne by every vessel using the port whether under pilotage or not. The cost has to be borne by the shipowners anyhow and such an arrangement would spread the burden broadly over them all.

There are wide differences between ports in the cost and method of maintaining the pilot service whilst in some places the provision of pilot vessels with crews and all the attendant expenses is not necessary at all as for instance the Manchester Ship Canal. The Manchester pilot boards his vessel and leaves her when in the locks—no boat being required.

The Mersey usually have four sea-going pilot vessels to maintain, an Inner Station at the Bar Light Vessel and an Outer Station at Point Lynas. A pilot vessel usually leaves Liverpool each morning with a supply of pilots for the inward rota, whilst a fourth vessel is in dock in reserve. These vessels have a fairly hard life especially in the winter months and regular and careful maintenance is essential if they are to carry out their work efficiently over a number of years. The pilot vessel on station is in the nature of a floating hotel accommodating pilots who are ferried across from the pilot vessel to the incoming ship in a small motor boat. This boat work calls for considerable skill and experience, and the overall cost of maintaining four large pilot vessels with staff, etc., is fairly high.

The Trinity House of London maintain similar vessels at Dungeness, the supply of pilots being kept up by tender from Dover.

In the Bristol Channel, however, a different system prevails, small motor boats are seldom used and it is the practice to steam the pilot vessel right up alongside the incoming ship to transfer the pilot. This method limits the size of pilot vessel which can be employed to vessels of about 100-ft. in length. In performing this manoeuvre the incoming vessel requiring a pilot is usually instructed to keep the wind and sea on the quarter with sufficient speed to give steerage the pilot vessel then boards on the lee side. Low lying tankers and submarines present difficulties when performing this manoeuvre and on such occasions a small motor boat is used to transfer the pilot.

In ports with a sheltered approach or where the traffic is not great, a 50-ft. motor-boat takes the pilot out to the incoming ship.

There is a growing tendency to regard the system of station keeping, more especially when it is situated some distance from the nearest port, as somewhat extravagant and wasteful in man-power. Pilots may sometimes be afloat in the pilot vessel for several days before they get a ship. In the days before W/T and R/T communication a vessel might arrive quite unexpectedly at the pilot station and it was necessary to have pilots ready to board at short notice. Nowadays vessels are able to give fairly accurate information in advance of their arrival at the pilot station and the arrival of a ship "out of the blue" without warning is becoming a rare event. The development of radar and electronic aids to navigation provides equipment which if used prudently enables an incoming vessel to approach shoal water with more confidence and in some cases may justify the withdrawal of the pilot station to more sheltered waters or closer to the port served. Such withdrawal would only be made after careful consideration in these days of ever increasing values of ships and cargoes. A reduction in the cost of maintaining the pilot service by using fast motor boats from the shore instead of keeping the large sea-going pilot vessels on station would not appeal to the industry unless the new method provided the same security and safe passage for vessels.

Pilotage Certificates.

Pilotage Authorities have been obliged to recognise that some vessels are so frequently in and out of their Pilotage District that the masters and mates acquire a very thorough knowledge of the District and to insist on such vessels taking a pilot would be something of an imposition. In such cases it is usual to allow the masters and mates to sit for an examination to test their local knowledge and a successful candidate is granted a Pilotage Certificate and so long as he continues to serve in vessels of substantially the same tonnage he will be exempt from pilotage. Some Authorities make quite a heavy charge for the grant of a Certificate, whilst in other Districts vessels commanded by officers holding a Pilotage Certificate are charged a percentage of what they would have paid if a pilot had been employed. The revenue to the Pilotage Authority from this source usually accrues to the Pilot Fund—this is the fund for administration. Certificates are much in favour in Belfast where 132 are issued, the Clyde 223, Trinity House, London, 358 and Liverpool 353.

This facility enables some shipowners to make considerable saving on pilotage dues.

(To be continued)

Los Angeles Port Expansion

Cargo Handling Capacity to be Doubled

It has recently been announced that the Port of Los Angeles is to commence an extensive expansion programme early this year which, it is estimated, will take some fifteen years to complete. Costing about $100 million, the scheme will more than double cargo-handling capacity and increase berthing facilities by 20 per cent. By 1972, the harbour will provide daily simultaneous docking space for 110 ocean-going vessels and will be able to handle 10 million tons of cargo a year in and out of Southern California.

The following projects are envisaged:

1. Five berthing slips, at a total cost of approximately $25 million, in the harbour west basin. The slips will be able to handle 10 cargo ships a day.
2. Two passenger-cargo marine terminals, costing $8 million, to accommodate the larger ships of the future. The terminal will be built in the west basin area, the northern part of the port closest to Los Angeles, and will mark the southern terminus of a new $100 million roadway from the downtown district.
3. A $5 million loader for inbound and outbound bulk cargo to provide expeditious loading and unloading of large ocean-going vessels with such cargo as iron ore. This will give an increase of not less than a million tons in both import and export trade.
4. Two transit warehouses. Each will measure 1,000 by 200-ft. clear span and cost $2.5 million.
5. Two cargo terminals, to provide an additional 3,000-ft. of berthing space, at a cost of $1.5 million each.
6. The dredging of port fairways, channels and slips to a minimum depth of 45-ft.

The Federal Government will be asked to allocate $20 million. The remaining funds are to be allocated to projects still in the preliminary stages. One now planned is a $30 million replacement for cargo sheds on Terminal Island. Another for the immediate future is a $5 million expenditure for construction of roll-on roll-off facilities for sea/land traffic.

This extensive expansion programme has become necessary owing to the considerable increase in general cargo traffic which has been averaging as much as 15 per cent. a year. At this rate, the port authorities must make provision to appreciably increase the present capacity of the port within the next few years.

Dry cargoes handled during the first four months (July-October) of the current fiscal year totalled 1,414,646 tons, a gain of 117,047 tons over the corresponding period a year ago. During the fiscal year ending June 30, more than 4,426,000 tons of dry cargo passed through the port, an increase of 244,190 tons over the preceding 12-month period.

Radar for European Waterways

Development of Navigation on the River Rhine

By Lt.-Commander H. M. KOCH, R.N.N.(Rtd.)

INDUSTRY is the life blood of Europe and, like a vast network of arteries, it is the Inland Waterways which carry the great bulk cargoes—minerals, building materials and foodstuff—to the sea ports and into the inmost corners of the European Continent (see Fig. 1).

The big European rivers and their branches such as the Rhine, the Danube, the Elbe, the Rhone, form the arteries of the European inland shipping routes, but many smaller rivers like the Scheldt, the Maas, the Seine, the Ems, the Weser, and the Po also play an important part and carry a considerable amount of traffic.

Canals such as the Rhine-Herne, the Weser-Datteln and the Mittelland, with large efficient locks, and canalised river branches with their ingenious hydro-electric works which supply power to the factories along the waterways, provide direct connections between most of these rivers. Other canals such as the Amsterdam-Rhine and the Dortmund-Ems connect large sea ports and industrial centres with these main shipping routes.

This present system of waterways is continually being modernised and extended and many ambitious projects are already in hand or under consideration. One of these is the canalisation of the River Mosel, a branch of the Rhine which joins this river near Koblenz. The canalised Mosel will provide a direct shipping route from the steel and iron plants and coal mines in the Saar, Lotharingen and Luxemburg to the Rhine, the Ruhr area and the North-Sea ports of Amsterdam, Rotterdam and Antwerp. Also under consideration is the extension of the high-Rhine shipping route from Basle to Lake Constance (see Fig. 2), which will give Western Austria (Bregenz), North East Switzerland and South Germany a cheap transport route to the North Sea. This project requires a shipping tunnel near the famous Rhinefall of Schaffhausen which, as a nature monument, has to be preserved.

The most important project for the extension of the West-European Inland Waterways system is the connection between the Rhine and the Danube on which work was started some years ago by canalising the River Main which joins the Rhine near Mainz in Germany. Progress has been such that it is expected that in 1961 a direct connection between Rotterdam and Bamberg in Southern Germany will be established for vessels as large as 1,500 tons. Work has also started on the canal connecting Bamberg with the Danube and, when these projects are finished, an international shipping route will be available from the North Sea Ports to

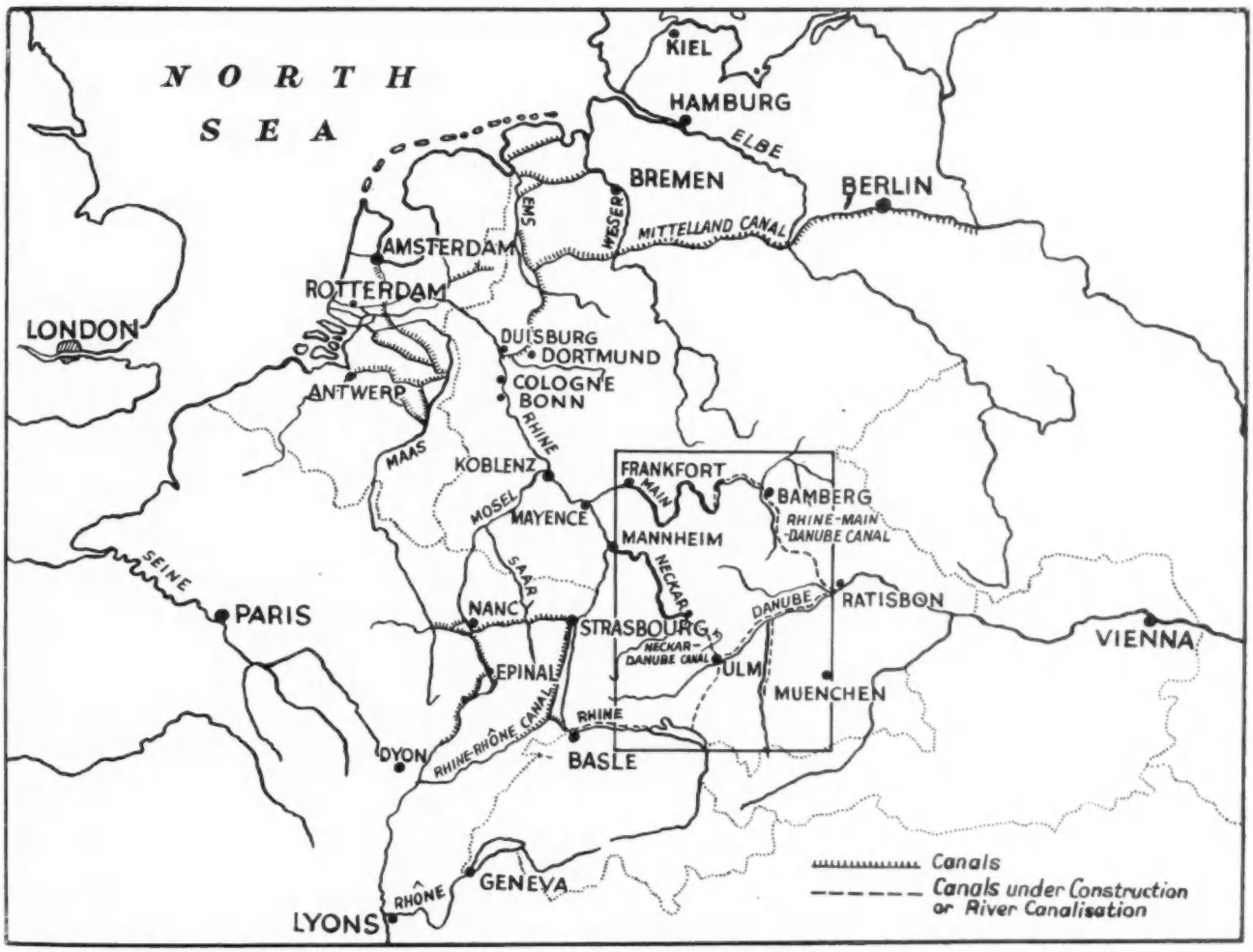


Fig. 1. Map of West-European Inland Waterways with (inset) the extension of Rhine Shipping to the Danube via the Rhine-Main-Danube Canal and the Rhine-Neckar-Danube Canal.

Radar for European Waterways—continued

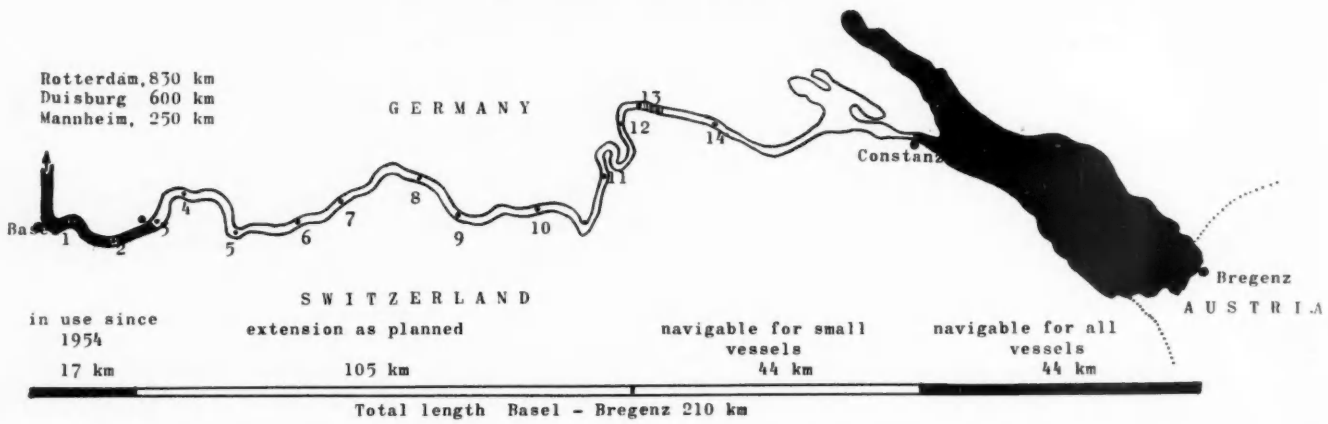


Fig. 2. The extension for High-Rhine shipping from Basel to Bregenz. 14 dams with additional hydro-electric power plants and locks are required. Seven dams with electric plants and 2 locks are completed. The total electric power which will be available when the work is finished will be about 4,500 million KWh per annum.

Southern Germany, Austria, Czechoslovakia, Yugoslavia, Hungary, Bulgaria, Rumania and Russia. The canalisation of the River Neckar, which meets the Rhine near Mannheim, together with the canalisation of the Upper Danube between Ratisbon and Ulm, will provide for a second Rhine-Danube connection with subsequent branches to the important German cities of Stuttgart, Augsburg and Munich.

The Rhine is the centre around which all these projects are planned and executed.

Many books have been written about the Rhine and the important role it has played down the ages. The castles crumbling on the massive rocks which border the River in central Germany have been the silent witnesses of many historic sagas. Richard Wagner was inspired by these surroundings when writing his operas "Das Rheingold," "Die Valküre," "Siegfried" and "Götterdämmerung." From remotest times the Rhine has also played a part in war which did not end with the jousts of mediaeval knights but culminated in the grim struggle of the modern armies for this vital strategic defence line.

The Rhine is a mountain river with a navigable length from Basle in Switzerland to Rotterdam in Holland of about 900 kilometres (approximately 560 statute miles). When navigating from Rotterdam to Basle a Rhine vessel has to climb about 750-ft. along a river which presents a great variety of navigational problems caused by the very strong tide in the middle and upper parts of the river, a great divergence in water level during the various seasons of the year, many submerged or partly submerged rocks, leaving over certain stretches only a very narrow and winding channel, and sand and gravel banks which are constantly shifting through the force of the water so that, particularly after a period of high water, the course of the navigable channel over large stretches of the river may have changed completely.

The regulation of the river and the responsibility of keeping the navigable channel at a certain minimum depth are in the hands of the border countries which are organised in an international committee, the Central Rhine Committee in Strasbourg. Apart from the border countries—Switzerland, France, Germany, Holland and Belgium—the United Kingdom and the United States are also represented on this Committee.

Thousands of breakwaters or groynes are used to guide the stream and scour a navigable channel of even depth. Most of these breakwaters are submerged during periods of high water and only in the lower regions of the river, where the current is not too strong, are they properly marked with buoys. The navigator has therefore to know by experience the position of these breakwaters relative to the banks and certain landmarks, and the course the navigable channel takes between them. This requires great skill and many years of experience.

When navigating from Rotterdam to Basle, the captain of a Rhine vessel will, in the lower parts of the river (between Rotterdam and Cologne — 305 kilometres), meet a navigable channel varying in width between 200 and 300 metres. Near Rotterdam the Rhine is a tidal river, the current being controlled by the tidal streams and water heights in the North Sea. Some kilometres upstream from Rotterdam this tidal effect ceases and the strength of the current is mostly governed by the slope of the river bed. This slope varies between Rotterdam and Cologne from 7—12-in. per statute mile, causing a current of 2—3 knots. In the Middle Rhine from Cologne to Sondernheim (315 kilometres) the slope of the river bed increases and with that rise the speed of the current. The Middle Rhine passes in its flow the well-known mountainous regions centred round the Lorelei Rocks. Over these stretches the current increases to 5—6 knots, whilst in the rapids near Bingen (see Fig. 5) a navigable channel between the partly submerged rocks of only 40 metres (120-ft.) is left.

In the Upper Rhine between Sondernheim and Basle (200 kilometres) the navigable channel is usually not wider than 100 metres and it does not follow the contour of the river itself but winds

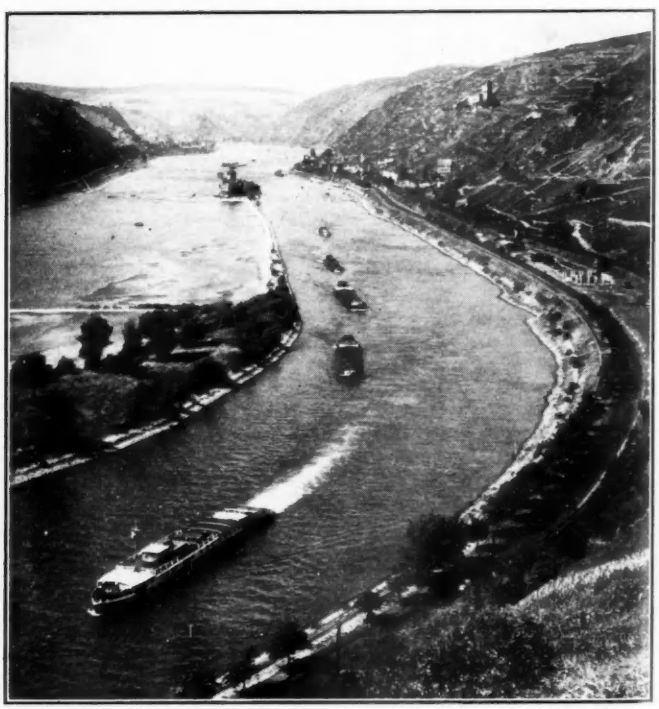


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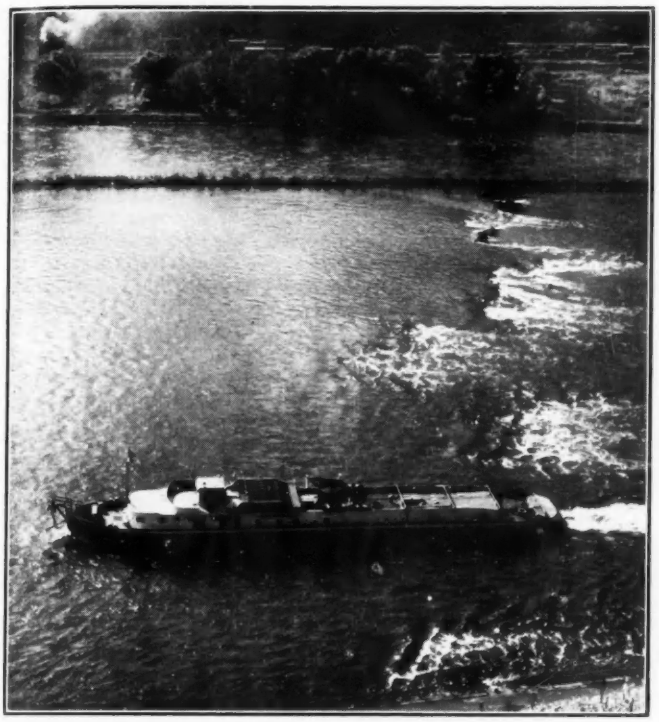
Fig. 3. The Rhine near Kaub. The Dutch tug "Njord" towing four barges.

Radar for European Waterways—*continued*



[Copyright photo by Frits J. Rotgans, Amsterdam]

Fig. 4. A strong diesel tug passing the Bingen Rapids (see also Fig. 5). Immediate foreground upstream passage, in centre rocks and top (beyond breakwater) downstream passage.

from side to side round the huge gravel shoals and as directed by the breakwaters. The navigable channel over this stretch of the river must be followed carefully and considerable local knowledge is required, as, especially after a period of high water, these many gravel banks may have changed their shape considerably or may even have moved into a new position. The speed of the current in these regions of the river has increased again due to the fairly steep slope of the river bed. Over the last 100 kilometres this rise amounts to between 5 and 6-ft. per statute mile. Consequently the current increases to 6—9 knots.

The Rhine as an International Shipping Route.

The River Rhine is the most important of the European shipping routes and it carries perhaps a greater volume of traffic than any other river in the world. The present shipping capacity on the Rhine approaches the 7 million tons mark and the interested visitor will notice vessels and barges under Swiss, French, German, Dutch, Belgian and even Austrian and English flags.

This traffic consists nowadays of about 2,500 high-powered motor vessels, varying in size between 300 and 2,500 tons. Apart from these motor vessels, there is a great number of non-motorised barges of up to 4,000 tons capacity. These barges are pulled by tugs in strings of up to eight in one tow. The largest tugs are powered by strong diesel engines driving as many as four separate propellers.

For navigating the upper regions of the river with its very strong current the individual motor vessels require almost one horse power per ton cargo carried, whilst the tugs have to reduce the length of their tows to two or three barges.

Some figures may be of interest to illustrate the amount of cargo carried over this river. There are two points along the Rhine for counting the amount of cargo transported on the River. The first one is Lobith, the Dutch-German border station, where the Lower Rhine traffic is counted. In 1955 the total cargo that passed Lobith in up and down stream direction amounted to nearly 50 million tons. Near Koblenz, the counting point for the Upper-Rhine traffic, nearly 40 million tons of cargo passed in both directions during that year.

Basle in Switzerland is the largest port in the upper regions of the Rhine which can be reached by vessels of approximately 1,500 tons. Almost 50 per cent. of the Swiss imports and exports are handled via this port and in 1955 the cargo amounted to approximately 5 million tons and about 8,000 vessels and barges arrived in this port during that year.

The Development of Rhine Shipping and the Introduction of Radar on the Rhine.

The use of the Rhine for transporting goods and passengers dates back to the Middle Ages, but it was not until the 19th Century and the introduction of the steam engine that regular traffic on the lower parts of the river could develop. Switzerland had to wait until 1904 before the great difficulties in the Upper Rhine shipping were conquered with the arrival of the first tow in Basle on the 2nd June of that year. This was achieved by the initiative of Mr. Rudolf Gelpke who in 1919 founded the present Swiss Shipping Company Limited at Basle. This Company—which in London is represented by Alpina Limited—in conjunction with Decca Radar Limited, initiated in 1953 the trials with radar as a navigational aid for Rhine Shipping.

With the construction of the Rhine regulation works between Strasbourg and Istein near Basle in 1930 and the completion of the canal and locks near Kembs in 1932 which provide a safe by-pass for the Istein rapids, the traffic to Basle increased to such an extent that by 1937 a record turnover of 3 million tons of cargo in Basle was reached.

During the second world war as a result of an allied bombardment of the locks at Kembs in 1944, the Upper Rhine shipping came to a standstill again and the through traffic between Rotterdam and Basle was not resumed until April, 1946.

In spite of the fast development of Rhine shipping since the war, the age old traditions with regard to the social aspects of the River have not changed much. Until very recently all motor vessels and barges had a single crew consisting of captain, mate and one or two deckhands. As a system of regular relief crews did not exist and a return journey between Rotterdam and Basle used to take anything between three to six weeks, captains and mates had their family on board: this gave rise to serious problems regarding the education of their children and other social aspects.

There are no lights for navigation during the night along the banks and therefore most traffic stops and anchors after sunset. Only very few ships on express service try with the aid of moonlight or starlight to proceed during a clear night: frequent reduc-

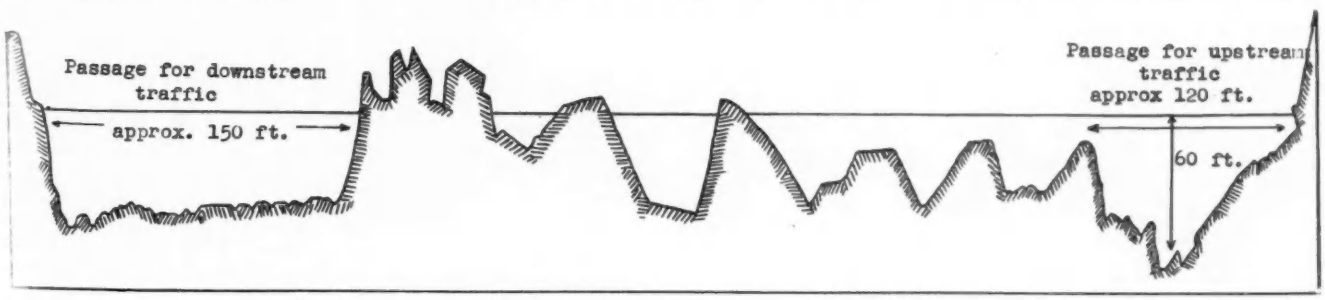


Fig. 5. Cross-section of the Rhine near Bingen, showing the Bingen Rapids.

Radar for European Waterways—continued

Fig. 6. Radar picture of the Rhine near Boppard. Range scale 800 metres. About 13 vessels all navigating in the upstream direction are shown.

tions in speed are necessary and a great strain is placed on the navigator. Regular shipping hours are therefore restricted to twelve hours during the winter and fourteen hours during the summer months. These restricted shipping times did not call for a double crew. Progressive shipping firms made trials with a double crew system for day and night traffic, but they had to give up these experiments as the very dark nights and fog caused many delays and made the double crew system an uneconmical proposition.

The hours of fog which hinder navigation on the Rhine may be seen from the following figures for the Upper Rhine in 1955. They were 25 per cent. of the available shipping hours in October, 50 per cent. in November and 35 per cent. in December. There is less fog during the other months of the year, although early morning mist and local fog patches over short stretches of the River are the cause of many delays.

It is therefore not necessary to point out the extent of the shipping time which can be gained if a navigational aid becomes available which enables a vessel to continue its journey through fog, bad visibility and darkness. Such an aid for a fast flowing river with many navigational hazards must, however, comply with the strictest requirements with respect to accuracy, reliability and simplicity As Rhine vessels are smaller than sea-going ships and are designed on entirely different principles, the layout of any navigational aid must be carefully adapted, while economy in costs, installation and maintenance are equally important.

The great need for a navigational aid on this River has for the last six years tempted several manufacturers of radar equipment to introduce their marine radar for use on the Rhine. However, the results which were obtained during the trials were disappointing and all sets had to be dismantled again.

In 1953 Decca Radar Limited resumed experiments, and for more than two years radar trials continued on board the m.v. "Valcava," a motor vessel of 714 tons and 450 h.p. belonging to the Swiss Shipping Company in Basle. The m.v. "Valcava" is approximately 200-ft. long and 23-ft. wide. Numerous journeys were made between Basle on one hand and Rotterdam, Amsterdam and Antwerp on the other. A great number of experiments were carried out, particularly in the Upper Rhine and in the mountainous stretches of the Middle Rhine. On many occasions the wheel house was blacked out to simulate the conditions prevailing at night and in the densest fog, with the object of discovering and analysing the characteristics of a radar suitable for this type of navigation.

These trials with the m.v. "Valcava" on the Rhine have been the subject of an article in the Journal of the Institute of Navigation ("Radar for River Rhine Navigation," Vol. VIII, No. 4, October, 1955). Decca Radar has developed to the specifications set by the results of these trials and studies a new type of radar specially adapted to river navigation with a particular application to the Rhine and European Inland Waterways. This radar is the Decca Type 214, a derivative of the Type 212, the new marine radar set recently introduced for use at sea.

The principal characteristics of this radar are given as follows:—

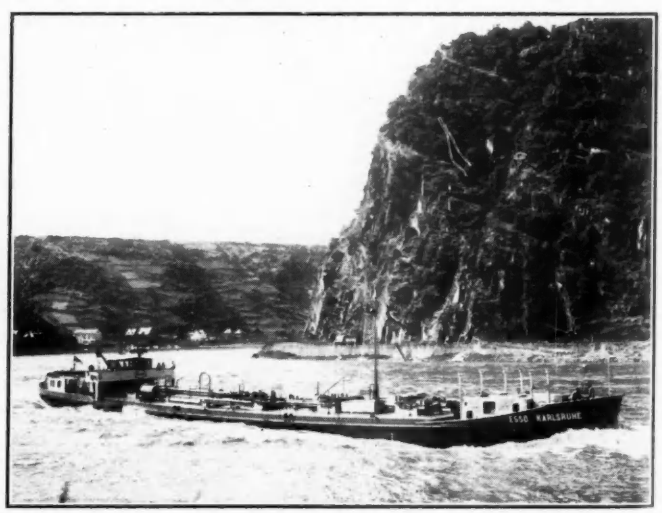
Wavelength	3 cm.	Range Scales	800 m.
Peak Power	10 kW.		1200 m.
Pulse Length	0.05 μ sec.		1600 m.
Beam-width	1.2°.		2 km.
Range Discrimination	10 m.		5 km.
Minimum Range	15 m.		10 km.
Display Diameter	23 cm.	Off Centring to 1/3rd of display radius.	

The most important features are a large scale picture with remarkably good definition and a display which can be off-centred by one-third radius downwards so that by using the short range scale of 800 metres (see Fig. 6) a greater range in the direction in which the ship proceeds can be displayed without losing any of the details required for navigating close to a bank or in the midst of other shipping. The design of the receiver gives a minimum range of 10—15 metres, considered from the aerial itself, and a range discrimination of 10 metres.

Apart from the presentation of a radar picture, it became apparent in the course of the trials that, in the absence of visible landmarks, whether at night or in fog, it was essential to give the captain some means of steering the vessel accurately on the route revealed by the radar. This problem was solved by the development of an ancillary gyro instrument called the Rate of Turn Indicator. The position of the pointer on the dial of this meter—which is of very small dimensions—indicates the movements to port or starboard and the turning rate of the ship. The instrument is extremely sensitive and gives immediate indication of the least change of heading. The drift of the vessel in the navigable channel is not indicated by the rate of turn indicator but has to be watched on the radar display by reading the distance from the nearest bank.

How the River Radar is used on the Rhine.

When navigating the Rhine in clear visibility the various objects in the river such as other vessels, buoys and breakwaters are very



[Copyright photo by Frits J. Rotgans, Amsterdam]

Fig. 7. The Esso Karlsruhe, a German radar fitted Rhine tanker in the middle stretches of the river Rhine. The radar scanner can be seen just behind the wheelhouse.

Radar for European Waterways—continued

often passed at ranges as short as a few metres. When navigating with the aid of radar in fog or low visibility the captain will try to keep these objects at minimum ranges of not less than 50 metres. In narrow passages and in places where traffic is dense or where several vessels are anchored alongside each other this is not always possible.

It is therefore essential that great care is taken when siting the radar equipment on board a Rhine vessel to avoid the possibility of discrepancies in judgment when the captain switches from normal visual navigation in daytime to radar navigation during the night and in fog. The position of the scanner, which on the radar display represents the centre spot, should therefore be as close to the wheelhouse—the captain's position—as possible and preferably on the vessel's fore and aft line. The siting of the radar display and rate of turn indicator in the wheelhouse are of equal importance. Both should be as close to the wheel as possible (see Fig. 8) and preferably between the wheel and the engine controls which are usually to the right in the wheelhouse. In that case it is possible for one man to keep the wheel, watch the radar display and rate of turn indicator and operate the engine controls when necessary.

This one man navigation is usually the rule on clear nights when the radar is used as an additional aid for safe and unstrained navigation. The Rhine Police Regulations—Rule of the Road—in their latest addenda insist that two men must be in the wheelhouse when the radar is used in fog and low visibility.

In such cases the captain will take position at the radar display and control the engines while the second man (either the mate or deckboy), will steer the vessel and watch its movements from the rate of turn indicator.

From the heading marker on the radar display the captain will see whether his actual course is correct and free of other shipping and navigational dangers. He then orders the man at the wheel to steer a straight course, and the helmsman will handle the wheel so as to ensure that the meter of the rate of turn indicator is kept at "0." To navigate a bend in the river or to steer free from other vessels, the captain orders a certain rate of turn either to port or starboard by saying "port 1" or "starboard 2." The man at the wheel will put on so much helm until the pointer of the rate of turn indicator has moved to port "1" (starboard "2"). When a faster turn is required turn rates up to six can be made. When the radar display heading marker is approaching the correct new heading, the captain orders "steady" again and the vessel will proceed on its new course. This very simple and accurate method of conning a large vessel in a narrow and winding channel has proved to be of great value for safe navigation: there is no chance of a misunderstanding between the captain and the helmsman and when he is ordering a certain turn, the captain knows exactly at what rate his vessel is altering course and with what accuracy it is keeping the required direction when the helmsman is keeping the vessel "steady." When going downstream the speed of the vessel over the ground may often be as much as 28 km./h. (between 14 and 15 knots). For navigating a sharp bend during the night with that speed, the correct amount of turn rate which has to be applied has to be known and the navigator acquires this skill by switching on the radar and rate of turn indicator during normal day time navigation and comparing the radar picture and turn rates with visual observations, at the same time making notes for future reference.

Fig. 8. Typical arrangement of radar display and Rate of Turn Indicator in the wheelhouse of a Rhine vessel. This picture was taken on board the m.v. "Cantenac," a French Rhine vessel from Strasbourg. The captain's wife is at the wheel.

[Copyright photo by Frits J. Rotgans, Amsterdam]

Fig. 9. Individual motor vessels navigating the river Rhine between the well-known Loreley and the village Oberwesel. Note the Rocks in the middle of the river which at higher water levels will be completely submerged.

After several up and downstream trips, the captains have acquired sufficient experience and they are capable of carrying on during the night and in low visibility.

Since it was clear to the Rhine shipping world that the application of radar opened great possibilities for speeding up traffic and saving tonnage, several Rhine shipping companies started their own experiments to find out in which way radar could be applied with the greatest possible advantages.

Sea-going vessels always travel day and night and they carry sufficient crew for a 24 hours watch system. Radar as a navigational aid at sea has not caused any basic changes in the shipping organisation and shipping schedules. It merely adds to the safety of the vessel and gains time in low visibility and fog.

River Radar for the Rhine and European Inland Waterways could be applied in the same way: in other words by leaving present single crew systems as they are and by using the radar merely to improve safety and to gain time in low visibility and fog, during the present 14 hours (12 hours in winter) shipping routine. As the river radar presents excellent possibilities for navigation during the night, most of these shipping companies immediately investi-

Radar for European Waterways—continued

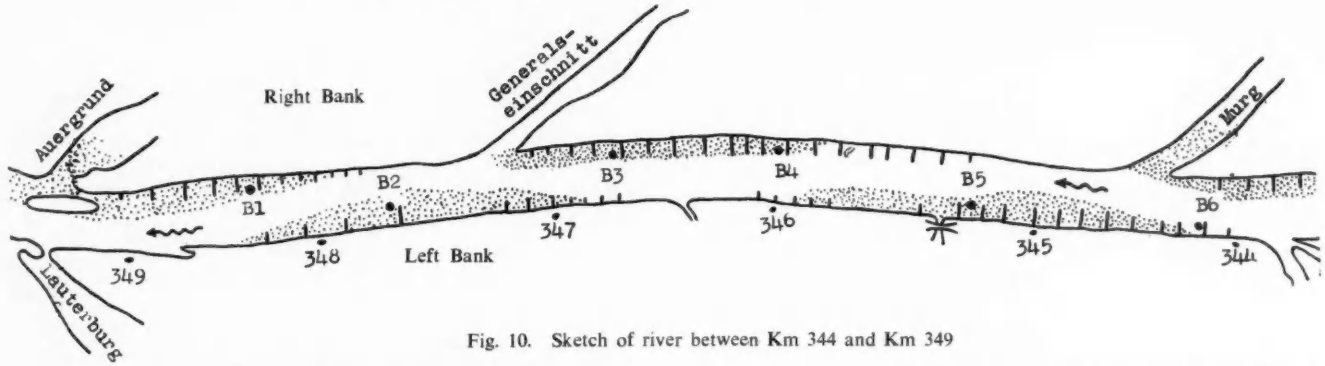


Fig. 10. Sketch of river between Km 344 and Km 349

gated the possibility of day and night traffic schemes and they introduced double crews on board the radar fitted vessels.

However, as the vessels were designed for single crew operation with only a few extra beds for the children, some redesign had to take place to house the extra man and the cook. Houses had also to be found for the families which from now on had to stay ashore. Several advantages of an important social nature have resulted from these big changes, the most important being that with the families based permanently ashore, the children can attend school regularly and receive a much better education.

With a double crew on board, the present working hours are automatically reduced from fourteen to twelve per day. Tankers, which turn round very quickly and usually do not stay in harbour for more than six hours, require a third relief crew. Some radar fitted tankers carrying about 1,500 tons of cargo have now three crews of which two are on board and the third relief crew ashore. Thus each crew—consisting of captain, mate, deckboy and engineer—stays on board for two weeks, working twelve hours a day, to be followed by one week at home on leave. The total average of working hours of these people is now eight hours a day and each crew has about seventeen weeks leave a year. It is only with the advent of the river radar that these great improvements in social life for Rhine people have been achieved. For general cargo vessels with radar and double crews, a relief crew is only required during the time the vessel stays in its home port for discharging and loading. This usually takes four days or more and this time is used for the double crew to take up the two days' leave guaranteed for each week.

The application of the river radar on the Rhine has during its first year crystallised into a number of shipping systems which can be summarised as follows:—

1. The normal day schedule, with single crew (14 hours during the summer and 12 hours in winter) with the radar used principally to assist navigation in fog and during the dark hours in the early morning and evening.
2. Extended day shipping schedules with reinforced crew for regular 16—18 hours traffic schemes during summer and winter.
3. Day and night shipping schedules with double crews (general cargo vessels).
4. Day and night shipping schedules with three crews of which two are on board and the third on leave (tankers).

It is anticipated that in future another type of day and night traffic schedule on the Rhine will develop in which a crew will only be employed to take a vessel over a certain stretch of the river from one station to the next, where another crew will take over and itself pass the vessel on to the third station and so on.

Radar Maintenance and Instruction.

The introduction of radar for European inland shipping is causing, as was explained above, considerable changes in the internal organisation of each Rhine shipping company.

More crews are employed; vessels have to be altered to house these extra men; loading and unloading systems have to be adapted to the quicker turn-round times.

The river radar is the focal point of all these revolutionary ideas and only through the river radar can they materialise.

These new schedules can only benefit the shipowners when each of their radar fitted vessels can rely on an equipment which is kept in perfect condition and which is available to assist navigation each moment of the day. It was therefore of paramount importance to have available, in the main inland waterway ports and along the Rhine, service stations which can when necessary check the sets and service them without causing delays to the vessels concerned.

Of equal importance is the question of the training of captains and crews in the use of the river radar and the rate of turn indicator.

Several experienced Rhine navigators and captains are employed by Decca to carry out this instruction in accordance with a carefully planned programme.

Rhine Buoyage and the Introduction of Radar Reflector Buoys.

Little use is made on the Rhine of buoyage. In the Lower Rhine up to Cologne alternative breakwaters are usually marked with a small buoy which can only be seen on the radar up to 600 metres.

In the Middle Rhine certain shoals and submerged rocks are marked with an even smaller type of buoy which is only discernable up to 200 yards.

In the Upper Rhine there are, because of the strong current, no buoys marking the navigable channel and all navigation is done by taking visual bearings on fixed landmarks (houses, trees, etc.), and by checking the vessel's position with the Km. marking stones situated along the river from Basle to Rotterdam.

On the radar screen, however, these visual marks on the banks cannot usually be recognised.

In close co-operation with the Wasserstrassedirektion, the Authorities responsible for the upkeep of the navigable channel in the German part of the Rhine, a new system for marking the most difficult stretches of the river with radar reflector buoys is being developed and trials are being carried out for choosing the most suitable types of radar reflector buoy.

The sketch (Fig. 10) shows a short stretch of the river between Km. 344 and Km. 349. The buoys, shown as B1—B6 in the sketch, do not mark the navigable channel. If used for this purpose they have to be moored in the strong tide where they would be easily washed away especially during periods of high water. Apart from this consideration, the channel changes continuously necessitating constant re-siting of the buoys with subsequent increase in expenditure. Fig. 11 shows the type of reflector buoy which will probably be used in future.

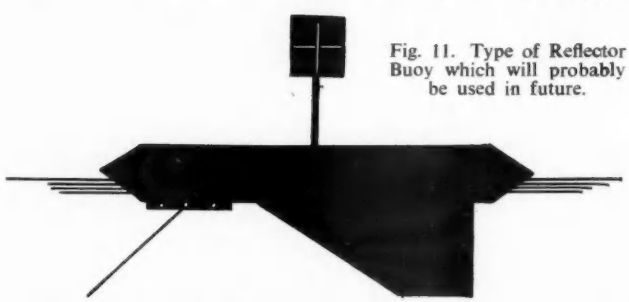


Fig. 11. Type of Reflector Buoy which will probably be used in future.

Radar for European Waterways—continued

The buoys in the proposed system are moored between the heads of two breakwaters so that they indicate not only the distance of the head of the breakwater from the bank but also the commencement of a line of breakwaters along the opposite bank. With the distinctive echoes of these buoys relative to both banks and his own knowledge of the river, the captain can immediately recognise the position of the breakwaters and shoals and so decide the course the navigable channel takes between them.

Example:

With his radar picture switched to 800 metres and off-centred to give him a range of 1,200 metres in the direction in which the vessel is proceeding, the captain when he arrives at Km. 350 will see the harbour of Lauterburg and the "Auergrund" on his radar screen. This information is sufficient to enable him to navigate at the required distance of approximately 40 metres from the left bank. Passing Lauterburg and keeping to the left bank, buoy number 1 will appear at a range of about 1,200 metres. When he has approached to within a range of 300 metres from B.1, the captain knows that he has to alter course to port to cross the river to the right bank. He will at that moment also see B.2 on his radar screen and he chooses his course so that the heading marker on the display is lying between B.1 and B.2 and pointing in the direction of the "Generals Einschnitt."

When passing B.2 the captain knows that the breakwaters along the right bank have stopped and that he can navigate along that bank at a range of 20—30 metres. When coming up to the "Generals Einschnitt" he has to alter course again to starboard and navigate in the middle of the river until he passes B.3, which indicates that the left bank is free of breakwaters again and can be navigated at close range. When B.4 has closed in to a range of about 200 metres, he changes his course to the middle of the river until B.5 is passed and the right bank can be used again as a navigational guide. Near the river Murg once more he changes course.

For the Lower and Middle Rhine it is not necessary to introduce this type of channel marking. It is considered sufficient if some of the present very small buoys are replaced by the radar reflector buoys designed for the Upper Rhine, so that the detection range will improve to about 1,200—1,400 metres.

The problem at present being studied is the marking of the piers of those bridges which do not protrude from the bridge superstructure, and cannot be seen on the radar. It has, however, proved possible to pass through bridges by radar and, ensuring that the vessel is at the right distance off the river bank, to clear the piers.

It would, of course, be much safer if at the same time the captain could see on his radar the actual position of the pier. The method most likely to be chosen will be the mooring of a small reflector buoy, some 15 metres upstream and downstream of the pier.

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The Hamburg Port Worker

Review of Conditions of Employment

The problem of dock labour is one which nearly every maritime country is trying to solve. As stated in our editorial comments, its core at the present time is decasualisation. This in itself is a problem engaging the attention of responsible officials in ports on all the five continents, who are also carefully studying the steps being taken in other ports than their own, to solve it. Every thoughtful contribution, therefore, is well worth consideration and we print below a summary of a study of the conditions of port work in Hamburg, produced by Dr. Werner Klugman of the University of that city.

Prior to the 1939/1945 war, Hamburg was the third largest port in the world and to-day is still the largest port in Germany. In 1955 its 12,000 dock workers employed by some 600 stevedoring concerns, handled 23.9 million tons of cargo, compared with 22 million tons in 1936—the last normal year before the war. This story of the Hamburg dock worker is told in one of a series of studies produced by the university concerned and is entitled "Die Hamburger Hafenarbeiter — Soziale Problemebeim Guterumschlag." The following summary of Dr. Klugman's work has been extracted from a recent issue of the International Transport Workers' Federation Journal and thus naturally presents the study as seen through Union eyes.

Working Conditions.

In the first section, which deals with working conditions, the article states that the records in the port of Hamburg before the first World War reveal a story of abuses and shortcomings. The reasons are not far to seek, and indeed the conditions obtaining in the port may be regarded as the inevitable consequence of the rapid developments which took place during the period of the port's expansion. Not least among the factors contributing to these unsatisfactory conditions, which produced the unrest culminating in the great strike of 1896/7, was the loosening of the ties binding employee and employer which accompanied the growth of large stevedoring concerns and wharfingers, coupled with the large influx of new labour resulting from the expansion of commerce and the change-over from sail to steam. The latter brought a change in the ratio between the size of crews and the amount of cargo carried by individual vessels. No longer were the crews able to handle the greater part of the cargoes and this work was increasingly taken over by dock labour.

The second half of the nineteenth century also saw a considerable extension of the area given over to port facilities and installations. A decision was made to construct an open tidal basin with berthing and warehousing facilities on the southern bank of the northern arm of the Elbe. An entrepot was created on the Kehrwieder—Wandrahm island necessitating the pulling down of homes housing some 20,000 to 24,000—most of them the families of dock workers. The days when a dock worker could see what his job chances for the day were like by, as it were, glancing out of his bedroom window, were gone. His home was now usually at some distance from his place of work which, as a result of the port's expansion on the far side of the river, could be reached by land only by a long and circuitous journey. And when he got there, the docker was not sure of finding work to be done. There was no dock-labour employment system in operation in those days and much time—and money—was spent in the many public houses in the area, the proprietors of which exercised an unwholesome influence on the waterside—in many cases acting as agents for the provision of dock labour whereby, presumably, those who owed them the most money got the first jobs.

Employer-Employee Relations.

The various sources of friction and unrest in the port, when analysed, may be reduced to one main cause—the failure to organise the labour market to keep pace with the rapid strides which industry was making towards the end of the last century. These developments, on the employer side, brought vast shipping and constructional interests into being. On the employee side, no such far-reaching or large-scale changes can be noted. All we see is the growth of the "middle-man," dealing in dock labour, in place of the multitude of small firms concerned with particular aspects of the countless activities connected with the movement of ships and their cargoes. The reward of these intermediaries, who soon acquired a position of power in dockland, was out of all proportion to the real value of their services.

It was under such conditions that the Hamburg dock workers first began to organise in trade unions. Records mention an organisation of daily-paid lightermen founded in the year 1854, who were successful in getting certain wage rates adopted. This was followed in 1872 by the Hamburg-Altona Port Workers' Union. Both unions collapsed during the strikes in the 70's. Other organisations were called into being but, for the most part, were short-lived. It was not until January 1st, 1891, that the solid foundation of present-day trade unionism among Hamburg dock workers was laid with the creation of the German Dock Workers' Union.

The Hamburg Port Worker – continued

This union by no means included all those employed in the Hamburg docks, and its membership fluctuated considerably. In 1910 it merged with the Transport Workers' Union which later changed its title to the German Transport Federation—Deutscher Verkehrsbund—1923, and subsequently (following its merger with the Union of State and Municipal Employees) to Federated Union of Employees in the Public Utilities and Road and Passenger Transport in 1930. After the second World War, the Union of Transport and Public Service Workers (ÖTV) took over representation of the interests of the dock workers. On the international plane, the dockers have been affiliated to the ITF since 1898. For their part, the employers formed an association in 1890 with the express object of preventing strikes, but which also was intended to pursue "positive socio-political objectives." The formation of permanent associations of both dockers and employers meant that the stage was thus set for the great strike of 1896/7.

Improving Conditions.

The Hamburg dockers' and seamen's strike, which began in the Autumn of 1896, collapsed at the end of eleven weeks, largely by reason of the numbers of strike-breakers the employers were able to bring in from outside. It was successful to the extent that it drew attention to the unsatisfactory conditions in the port and the urgent need for their improvement. A Hamburg Senate Commission set up after the strike to enquire into its causes confirmed the justice of the dockers' complaints. These centred round the inadequacy of the machinery for controlling the registration and placing of dock labour, the absence of anything approaching a guaranteed minimum wage, the failure to regulate hours of work or to provide adequate means of transport to the place of work, and the lack or inadequacy of protective legislation covering accident, sickness and unemployment benefits and pensions. The strike also served as a reminder to the employers, who had found it very costly, that improvement in these spheres might well prevent a repetition in the future. A move was made in the direction of decasualisation of dock labour in 1907 with the creation of an employers' organisation—the Port Employers' Organisation (Hafenbetriebsverein) with the object inter alia of "maintaining and promoting friendly relations between employers and employees." As a means towards this end the organisation of port and shipping interests envisaged: the organisation of the labour market by the creation of employment agencies; the regulation of employer/employee relations by means of fixed wage scales, the engagement of contracted labour on behalf of the organisation's members; and establishment of welfare facilities for the benefit of the workers. By 1913, the Port Employers' Organisation was the only body responsible for labour engagement and placing in the docks except for these berths which were operated directly by the State.

Under the dock labour registration scheme operated by the Organisation, dock workers were divided into three classes; "permanent workers," being regular employees of one concern; "auxiliary workers," not on the books of any one firm but registered with the Organisation and available to supplement the "permanents" at need; and "casual workers," recruited only during peak periods and dismissed when their services were no longer needed. [This is similar to the method in many British ports prior to the introduction of the National Dock Labour Scheme. The three classes of labourers were often called "permanent"; "preference"; and "extra."—ED.] The first two classes were issued with dockers' "cards" and the members of the Organisation undertook to engage only card holders. The "casuals," on the other hand, were merely given "tickets" which were withdrawn when their particular job was finished. This arrangement had the effect, over a number of years, of establishing a more normal relationship between the number of dock workers and the amount of work available. The over-large body of casuals was reduced in numbers, whilst the "auxiliary workers" could be reasonably sure of getting enough work to ensure them a living wage. After the first World War, the registration and placing of dock labour was taken over by the State.

Social Insurance.

Health insurance was made compulsory for the great majority of dock workers under an act of 1914 which included insurance provisions for those "not permanently employed." In 1931, the Hamburg Senate enacted further orders concerning the contributions to sickness and unemployment insurance to be made by casual labour. Under the regulations in force, insured workers are required to affix a weekly insurance stamp to their work cards at the beginning of each week while the employer purchases a day stamp for each day the worker is employed. The daily contribution stamp is provided by the municipality in the event of unemployment. It also pays the employers' contribution to the unemployment insurance fund at the same time. Entitlement to unemployment benefits accrues after thirty-nine weeks of casual employment.

In the field of retirement pensions, the ÖTV concluded an agreement with the Hamburg Dock Labour Employers' Association (Arbeitsgemeinschaft Hamburger Hafen-Fachvereine e.V.) on 5 June, 1953, whereby provision was made for retirement pensions for all dock workers not covered by a scheme introduced for its employees by the Hamburg Port and Warehousing Company (HHLAG) in 1936. This provided for a pension after ten years' continuous service amounting to thirty-five per cent. of the wages last drawn and increasing by two per cent. for each additional year of service (one per cent. after the twenty-sixth year). On this basis the maximum pension of seventy-five per cent. of wages is reached after thirty-five years' service. In the event of incapacity for work due to injury sustained during the course of employment, pension entitlement accrues whether or not ten years have been worked with the same firm.

Under the ÖTV supplementary scheme all dock workers in possession of a regular dock workers' card on retiring at the age of sixty-five get DM 25 (about £2) a month in addition to their normal old age pension, provided they have worked in the docked for a continuous period of fifteen years and have no other source of income apart from their pension. The condition regarding length of service is waived in the event of injury sustained at work and incapacitating the worker for for further service. The pension is increased by DM 1.25 a month for each additional year of service. This supplementary pension is not payable however if the docker continues at work, and any years of service after the age of sixty-five do not count towards the increase of pension. The employers' organisation meets the costs of this supplementary pension scheme.

Hours of Work.

In the 1890s the working day in the Hamburg docks was from five o'clock in the morning till eight at night, i.e. fifteen hours including breaks of about two hours' duration. About this time, however, organised dock labour won the ten-hour day, followed, in 1913, by the nine-hour day. The eight-hour day was introduced at the end of the first World War (1914-18), and with it the three-shift system, the first being from seven in the morning to 3.30 p.m., the second from 3.30 p.m. to half past eleven at night, and the third from 11.30 to seven the following morning. Each shift includes a break of thirty minutes.

In the matter of paid holidays, regular dockers get twelve days a year in the first to the fifth year of service under an agreement of February, 1952. They must have held a permanent dock worker's card for the entire period or have been employed for that time without a break. Providing these conditions are satisfied, the paid holiday is increased to fourteen days in the sixth and seventh year and to sixteen days thereafter. Casual dock labour registered with the labour office have no paid holiday entitlement.

Wages.

Hamburg dock workers are paid either on a time basis (so much a shift) or at piece rates. Nowadays piece-rate working applies chiefly to the handling of fish or coal. Work outside the normal eight hour day (weekdays from 7 a.m. to 3.30 p.m.) is paid at the rate of 120 per cent. for the second and 125 per cent. for the third shift. On Sundays and public holidays the duration of a shift is reduced to six hours, with overtime rates of thirty per cent. for the first and second shifts and fifty per cent. for the third and fourth. Under an agreement of 14th October, 1955, the basic rate for German dock workers was fixed at DM 16 (about £1 7s.) a shift. This is the minimum basic rate. Specialised workers get higher rates. In the case of certain goods, a "dirt-money" allowance is also made.

The Hamburg Port Worker—continued

The Hamburg Port and Warehousing Company (HHLAG) pays on a somewhat different basis. Employees of this company on the permanent register receive family allowances in addition to their normal wages, which are based on the hour and not the shift. This allowance is the same as that applicable to workers in the public services and was continued by the company when it took over the State Dock Administration. Employees continue to draw wages in the case of illness, injuries received whilst at work, and in the event of approved absence from work for short periods. Sick pay amounts to ninety per cent. of wages for a maximum period of five weeks. In the case of injury, no deduction is made. Dockers on the permanent payroll of the company are entitled to a retirement pension after ten years' unbroken service as a consequence of which their hourly rates are somewhat lower (about 1½d.) than those of the "casuals."

Classification.

Mention has already been made of the dock labour registration scheme introduced at the turn of the century and still in force to-day under which dock workers were classified as "permanent," "auxiliary" or "casual" employees. The first-named, dock workers employed by individual wharfingers and dock enterprises, form the "hard core" as it were of the workers employed in the docks. They are on the permanent payrolls of the various concerns and their numbers are calculated to ensure that the employer has work for them even during slack periods. [This and the next paragraph are pertinent to Mr. Cave's suggestion.—ED.]

The second class, now known as general dock workers, constitutes a reserve on which the firms requiring labour can fall back in case of need, whilst the third class, also known as dock workers class B, are casual labourers in that they are registered as unemployed at the labour exchange—under the special dock workers' section—receive unemployment pay and are called on only during peak periods when there are not enough permanent and general dock workers available. In the year 1951, there were 1,100 such "casuals" registered at the exchange. When such casuals work a shift, their unemployment pay is reduced by a certain amount—but not to the extent of swallowing their earnings. In practice, the shift plus modified unemployment pay system operates in such fashion that it is not worth the casual's while to work more than three shifts a week. This may be one of the reasons why it has been found necessary on peak occasions to fall back on labour other than normal dock workers, the labour exchanges being contacted for additional labour—mostly unemployed in the building, wood and metal trades. [Difficulties of this sort are inherent in decasualisation schemes. Under the National Dock Labour Scheme of Britain, for example, if men have "proved attendances" for the first four days of the week, it is often of little financial benefit for them to accept employment for the remaining 1½ days.—ED.]

The Guaranteed Wage.

Recognition of the need for stabilised earnings in the industry was evidenced by the employers' association at an early date when in 1907 it introduced the "contracted-worker system" whereby as many dock workers as possible were engaged contractually to perform any work allocated them by the association in return for a fixed weekly wage. [This also is pertinent to Mr. Cave's suggestion.—ED.] They could be required to work twelve hours every weekday (including a two-hour break). Organised labour was strongly opposed to the system, however, in that it imposed restrictions on the right to strike by reason of powers to confiscate the dockers' contributions to a compulsory so-called savings and benefits fund in the event of the contracted docker "breaking his contract." The year 1918 saw the end of this system.

In 1920 an attempt was made to revive the system "under consideration of the changed circumstances." The 3,000 registered dockers were divided equally into "A card" and "B card" holders, whereby the former were guaranteed regular employment by one of the dock enterprises and the latter constituted a general reserve in case of need. In view of the amount of work available, the scheme as operated put the "B card" holders at a serious disadvantage and a strike put an end to it after only three months.

Following this, the "short-time" system was introduced and lasted until the end of 1923. This scheme was based on the principle that the docks as a whole could not guarantee full employment regularly for all registered dock workers and that, by operating a scheme of short periods of work alternating with layoffs, all concerned would be guaranteed approximately the same earnings. Unemployment benefits served to supplement wages under this scheme.

A more rigorous application of this system was again resorted to in the years following 1935. Administratively the permanents and the general dockers were lumped together and the former were required to step down in favour of the latter as long as continuous regular employment could not be guaranteed to all. In practice this meant their being laid off after two days. Those authorities responsible for the scheme spoke of the "guarantee of a living wage due to the spirit of sacrifice amongst the dockers." This scheme, however, did not and could not ensure a reasonable minimum weekly wage, and earnings had to be boosted by a sort of supplement to unemployment insurance, the so-called "Hafenbeihilfe."

The first guaranteed minimum wage agreement had to wait until the end of the Second World War. On 1st February, 1948, the ITF-affiliated Transport and Public Service Workers' Union (ÖTV) concluded an agreement with the Hamburg dock labour employers' association under which permanent employees were guaranteed a weekly minimum wage equal to what they would earn if they worked six shifts, whilst the general dock workers received the equivalent of five shifts. The "casuals" registered with the labour exchange were not included in the scheme. Under an agreement of 1st June, 1953, the scheme was amended to include the principle of attendance money. It now lays down that general dock workers are guaranteed a minimum weekly wage equivalent to the working of five shifts, except in the event of their weekly earnings exceeding DM 98, and that they will receive attendance money amounting to DM 7 for each weekday they report for work but are not engaged. This meant that, under the former rate of DM 13.60 a shift, the docker working four shifts took home a little more than the equivalent of a worked five-shift week (two days attendance money more than covering the difference). With the rate now at DM 16, his take-home pay is somewhat less (DM 2) than what he would get if he actually worked five shifts. The cost of the guaranteed minimum weekly wage is borne by the shipping companies and brokers in that the stevedoring firms and other direct employers of dock labour add two per cent. to their invoices for services performed.

The Outlook.

With a well-organised trade union to watch over their interests, the Hamburg dock workers may be expected to move forward to increasingly improved conditions. One of the questions which is likely to prove more pressing in the near future is that of hours of work. Another matter of immediate interest is the provision of adequate housing facilities in the vicinity of the port to make good the damage sustained during the war, when a total of 300,000 dwellings were destroyed. Nor can the problem posed by increased mechanisation in the handling of cargoes be entirely ignored if labour management relations re to remain on a good footing.

Dr. Klegman's study emphasises the similarity of the difficulties which confront port operators all over the world. The problem has already been stated: How to have available a responsible and efficient labour force in an industry where (a) there are no standard conditions and (b) there is rarely continuity of work of the same kind at the same place for more than a few days. Decasualisation is now accepted as necessary part of the solution of the problem but decasualisation is bringing problems of its own. The more knowledge of port working conditions there is available, the more quickly difficulties will be resolved.

Waterford Harbour Improvement Scheme.

It was recently announced that the Waterford Harbour Board has accepted a tender of £236,364 in connection with a harbour development scheme, which includes the construction of a new quay for the cross-Channel service and the reconstruction of other quays. It is expected that work on the project will commence at the end of this month.

Radioactive Tracers in the Thames Estuary

Report on an Experiment carried out in 1955

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Introduction.

EXPERIMENTS with radioactive tracers were carried out in 1954 and 1955 to determine the movements of mud or silt in the Thames Estuary. The investigation was made at the request of the Port of London Authority in connection with the study of siltation in the Thames described in previous issues of this Journal[1]. The 1954 pilot experiment[2] was designed primarily to investigate the new technique, and its success led to the large-scale experiment which was conducted from July to November, 1955. The general planning and direction, and all matters relating to sedimentation and tidal hydraulics, were the responsibility of the Hydraulics Research Station of the Department of Scientific and Industrial Research. The Isotope Division of the Atomic Energy Research Establishment, Harwell, selected and prepared the radioactive tracers, and designed and constructed all the apparatus required for injecting and detecting the tracer in the estuary. The experiments themselves were made practicable by the ready co-operation of the Port of London Authority with the H.R.S. and the A.E.R.E.

The Object of the Experiment.

The pilot experiment of 1954 demonstrated clearly that a radioactive tracer could be used to follow the movement of mud from one part of the Thames Estuary to another. This pilot experiment, however, was not intended to provide much or any information about siltation in the Thames; the total activity injected was only 4 curies, and it was found impossible to obtain significant results at distances of much more than 3 miles from the injection point or for more than a few days after injection. It was clear from the results obtained that the tracer could be detected only when it settled on the bed, and it followed that detection was only possible in areas where temporary deposition was taking place at slack high water or slack low water, or in areas where accretion and consolidation were in progress as a result of recent dredging.

The main object of the 1955 experiment was to determine whether mud could be carried " upstream " in the Thames Estuary (see Key Plan, Fig. 1); that is to say, whether mud dumped in the eastern or seaward part of the estuary could in the course of successive longitudinal oscillations on the flood and ebb tides be subject to a net landward movement and be deposited in the western or upper part of the estuary.

In order that a positive outcome to the experiment should carry the maximum conviction, it was decided to give the large-scale experiment an unfavourable bias by injecting the tracer in Gravesend Reach just after high water, in the early stages of the ebb. Injecting in this way, a net long-term seaward drift would have the effect of carrying the tracer gradually downstream and out to sea, some of the tracer being deposited in the accretion area in Lower Gravesend Reach but none being carrried up to the Barking Mud Reaches. If on the other hand a landward counter-drift were present near the bed, activity would be detected in Gravesend Reach —as before—shortly after injection, but the tracer might eventually be carried far upstream and be detected in Halfway, Barking or Gallions Reaches. In the latter case, the results of the experiment might be taken as positive evidence of an estuarine circulation capable of transporting mud landward or upstream.

It was clear from the results of the 1954 experiment that considerably more activity than was then used would be required if significant results were to be obtained at distances of 15 to 20 miles from the injection point and for several weeks after injection. After consultation with the Health Physics section at Harwell, the Isotope Division of the A.E.R.E. therefore proposed that 5 to 10 times the activity used in 1954 should be injected.

Materials and Equipment.

As in 1954, the isotope scandium 46 was used as a tracer[3]. It was selected for the following reasons:—

(i) it is a good source of high-energy gamma-rays;
(ii) it has a convenient half-life of 85 days;
(iii) scandium oxide is insoluble in water, but can readily be incorporated in glass;
(iv) the cross-section (in barns) makes it suitable for irradiation in a pile to obtain a satisfactory level of activity.

The tracer material had a specific gravity similar to that of Thames mud, and consisted of soda glass containing 1.5 per cent. of scandium oxide, Sc_2O_3.

The scandium glass was ground mechanically until its particle size distribution was almost the same as that of the inorganic constituents of the Thames mud. Many samples of mud from the Thames had been analysed before drawing up a specification for the size distribution of the scandium glass. The analyses revealed that from 20 per cent. to 35 per cent. by weight of the mud consisted of humified organic matter whose origin could not be determined with any degree of certainty. The inorganic fraction of the mud was observed to be very finely divided, a large proportion of

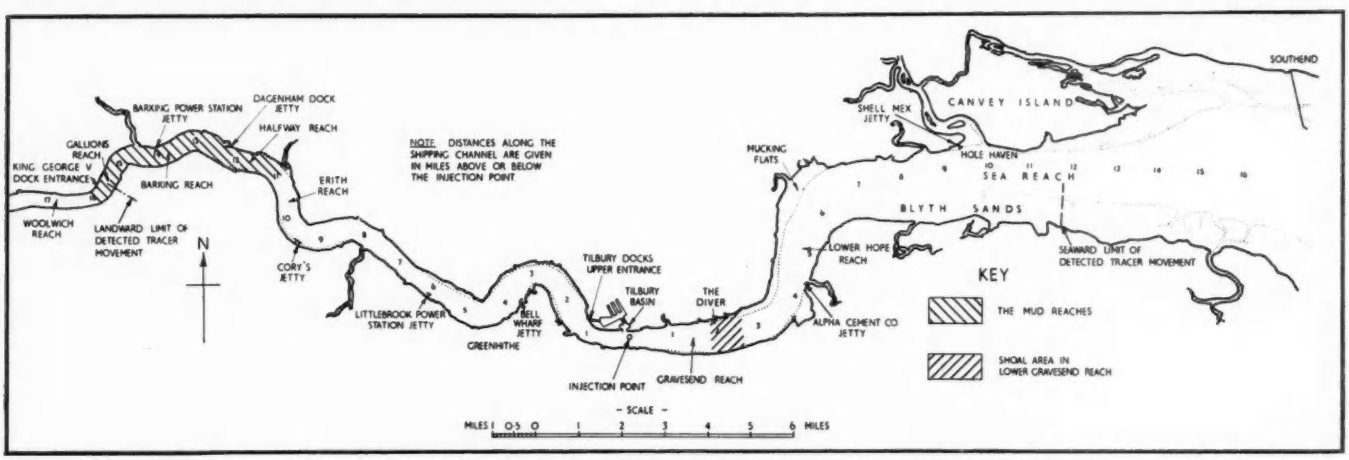


Fig. 1. Key Plan showing 1955 Experiment with Radioactive Tracers in the Thames Estuary.

Radioactive Tracers in the Thames Estuary—continued

it being in the clay range. The surface activity of the minerals which make up this inorganic fraction is high, and there is therefore a natural tendency for the mud in suspension to flocculate—a tendency which is greatly strengthened by the humic material derived from the organic fraction. As a result of these analyses, a proposed grading curve was drawn up, having a mean particle size of 0.035 mm. This grading is shown by the dashed curve on Fig. 2. The scandium glass was ground and sorted until the grading approximated closely to the specification. The final grading of the scandium glass is shown by the full curve on Fig. 2, from which it can be seen that the mean particle size was 0.045 mm. The tracer was irradiated in the Harwell pile for nine weeks in a neutron flux of 1.2×10^{12} n/sec/cm^2, and then allowed to decay for one week to eliminate short-lived radioactive products. 845 grammes of the graded scandium glass were finally injected into the river, the activity on the day of injection being 33.8 millicuries per gramme. The total activity was therefore about 29 curies.

The apparatus designed for the injection is illustrated in Fig. 3 and consisted essentially of a cylindrical steel container, closed by a spring-loaded lid at each end which could be opened when the container was lying on the river bed by pulling a release wire. A special stand was used to support the container on board the boat during the mixing process before injection took place.

For the underwater detection apparatus, gamma-ray Geiger counters were used in preference to scintillation counters because of their greater robustness and because they were easier to use in constructing a detector which would be sensitive over a large volume. Three detectors were constructed. Each consisted of three G24H low- voltage gamma-ray counters, working at about 400 volts into a cold cathode valve ratemeter circuit. About 100-ft. of screened cable led to a dry-battery-operated multi-range ratemeter aboard a survey launch. The counters were mounted in a waterproof brass container, weighing about 40 lb., which could be lowered to rest on the mud at the river bed.

Conditions Preceding the Experiment.

A survey of background activities in the estuary was carried out in the week, 27th June—4th July, 1955. The background counting rates at each place were recorded with a Geiger-counter detector resting on the bed and with it suspended 5-ft. above the bed. It was considered that this would provide satisfactory comparative data for use after the tracer had been injected. The background activities were observed at the following localities, the mileages indicating the distances below London Bridge.—

(i) at one-mile intervals in the centre of the shipping channel from Mile 8 (upper end of Woolwich Reach) to Mile 38 (Canvey Island);

(ii) at one-mile intervals on the north and south sides of the shipping channel from Mile 10 to Mile 16—to provide more detailed information on conditions in the "Mud Reaches";

(iii) at 3 or 4 spots in the accretion zone in Lower Gravesend Reach where dredging is often required—in the neighbourhood of the Diver;

(iv) at 2 spots on or near the low water line at Mucking Flats;

(v) at the bottom of two typical holes in Lower Hope Reach;

(vi) and at the following places.—

King George V Dock Entrance ...	Mile 10.3
Dagenham Dock Jetty	Mile 13.7
Cory's Jetty, Erith Reach	Mile 16.7
Littlebrook Power Station Jetty ...	Mile 19.9
Bell Wharf Jetty	Mile 22.3
Tilbury Docks Upper Entrance ...	Mile 24.7
In Tilbury Basin	Mile 26.0
Alpha Cement Co. Jetty	Mile 30.2
Shell Mex Jetty	Mile 34.3

It was found that the background activity was least in deep water, and that in shoal areas and near jetties it was in some cases between 50 and 100 per cent. greater. It was considered that during the search for activity which was to follow the injection, a **consistent** increase of 50 per cent. over the background counting rate at any point would be regarded as significant.

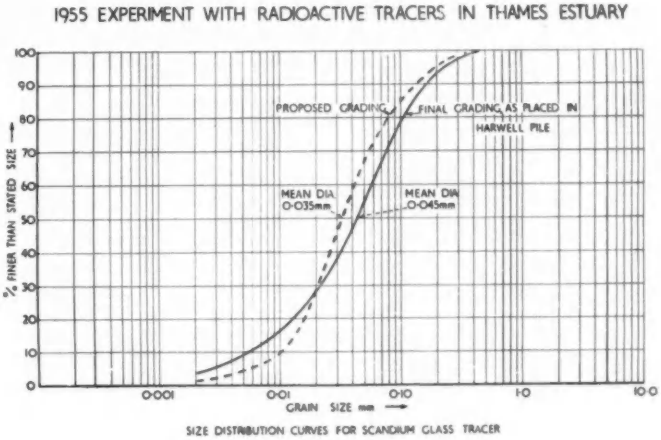


Fig. 2.

The position chosen for injection (see Fig. 1) was in the main shipping channel at the upper end of Gravesend Reach, abreast of the entrance to the Tidal Basin of Tilbury Docks, 26 miles below London Bridge. This is a deep, narrow part of the estuary where no accretion occurs. In the shoal area at the lower end of Gravesend Reach, however, frequent dredging is required; and the Port of London Authority agreed to carry out no dredging in this zone of accretion during the period of eighteen days immediately preceding injection, so that the radioactive material would not be unduly attracted by the rapid siltation which would otherwise be taking place in the recently-dredged area. On the other hand, for the week preceding injection a dredger worked on the north side of the channel in Barking Reach, abreast of the lower end of Barking Power Station Jetty, about 14 miles above the point of injection. It was hoped that if any of the tracer were carried so far up the estuary, much of it would collect in the newly-dredged patch—where rapid siltation would be taking place—and might thus be more easily located and detected.

A prerequisite to the success of the experiment was the existence throughout the period of observation of low river flows, in order that normal dry weather or summer conditions of circulation in the estuary should be maintained. This condition was satisfied, the river discharge being low from mid-June until the latter part of October. The mean, maximum and minimum flows for periods of 3 weeks before and 3 months after injection are shown in the following table.

Gauged Flow of the River Thames at Teddington Weir.

Period	Flow in cusecs Average	Maximum	Minimum
16th June—4th July, 1955 (19 days)	1649	2180	1152
5th July—4th October, 1955 (92 days)	549	1121	297

The Injection.

Before injection, the scandium glass—which had been brought to Tilbury by road, stored in two lead pots—was transferred to the mixing apparatus and container on board the M.V. "Broadness." In the container it was mixed with about 60 lb. of fluid mud. A few ping pong balls were also placed in the container; these were to be retrieved after injection, having served as indicators of the successful opening of the spring-loaded lids. Remote-handling techniques were essential throughout this stage of the work and precautions had to be taken to reduce radiation hazards to the operators.

The injection was carried out at 1500 hours B.S.T. on the 5th July, 1955, in mid-channel at Mile 26, off the entrance to Tilbury Basin, about 45 min. after high water. The tracer was successfully released on the river bed, being washed out of the container by the ebb current.

Search for the Tracer.

Two survey launches and their crews were made available for the search by the Port of London Authority, each launch being

Radioactive Tracers in the Thames Estuary—continued

equipped with Geiger-counter detectors. One of the launches was also fitted with Decca-Navigator equipment.

During the first day after injection, increases of activity at the bed of the estuary could be detected at low water as far downstream as Holehaven, 10 miles seaward of the injection point (see Fig. 1). The highest activities were found immediately below the injection point, in the neighbourhood of the "Artemis," and in the shoal area at the lower end of Gravesend Reach—in the middle and at the northern side of the main channel. At the end of the first tidal cycle, the activity was slightly above background in Tilbury Tidal Basin, and at the Upper Entrance to Tilbury Docks, 1.2 miles above the injection point.

During the first weeks of the experiment, the distribution of activity to seaward of the injection point was practically constant. In the shoal area in lower Gravesend Reach, activities of up to 8 times background were measured in the middle of the main channel. Activities of 1½ times background were recorded near low water mark at a few points in Lower Hope Reach, and also on the Blyth Sands at the western end of Sea Reach, between 7 and 9 miles seaward of the injection point. A number of thorough surveys revealed no excess activity elsewhere in Sea Reach. After the first day of the test there was no evidence of the movement of radioactive material in the seaward direction.

In the Tidal Basin at Tilbury, where siltation necessitates considerable dredging, the activity gradually increased to 3 times the background value during the first fortnight, and thereafter showed little variation, apart from the natural decay of the radioactive tracer.

The results of the search at positions above the point of injection were of particular interest. When increased activity appeared in reaches lying successively nearer the head of the estuary, it was usually first detected just above the ness at the seaward end of the reach. Other positions where radioactive particles had a temporary halt on their way to the "Mud Reaches" were in the bight at Greenhithe (4½ miles above the injection point), where from 2 to 3 days after the injection there was a patch of active deposit about ½ mile long and 500-ft. wide; and in the bight at Erith. The first traces of activity at Barking Reach (13-15 miles above the injection point) were detected 7 days after injection. This was not followed by any spectacular increase in activity in the "Mud Reaches"; the readings obtained in this area continued to be about twice background. On one day activity could be detected over a fairly wide area in Halfway Reach: on another, there would be little in Halfway Reach and more in Barking Reach. Accretion was occurring in these areas during the period of search, and it is probable that some of the radioactive particles were covered with inactive material which reduced the amount of radiation reaching the Geiger counters. The dredged area at Barking rapidly filled with silt and increased activities were found there on only two occasions. After a fortnight no appreciable radioactivity could be detected in the estuary from 1.2 to 13.0 miles above the injection point; and at no time were readings above the normal background obtained 15.5 or more miles above the injection point; that is to say, the tracer was to be found only in the central portion of the "Mud Reaches."

The surveys were continued at intervals for a period of 139 days after injection, the final upstream inspection being carried out on 21st November, 1955. The final survey seaward of the injection point was made on the 18th November, 1955, by which time the readings in lower Gravesend Reach had fallen to the original background level. As in the 1954 Pilot Experiment, it was found that the tracer could be detected only when the Geiger-counter units were on the bed—so that they were actually resting on recently deposited mud or immersed (wholly or partially) in a fluid mud layer.

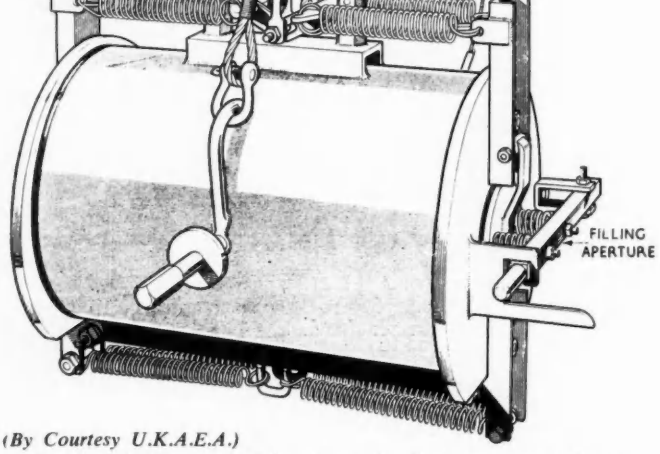
During the experiment it was necessary for the Port of London Authority to continue their normal dredging programme in the areas where siltation was taking place and where the Geiger counters showed that some of the tracer was settling. It is possible that appreciable quantities of the tracer were removed from the estuary in this way during the course of the experiment, but no worthwhile estimate of the activity so lost can be drawn up. The quantities of mud dredged from Barking Reach, Gravesend Reach and Tilbury Tidal Basin from July to November inclusive are given in Table 1. It will be seen that the grand total of material dredged from these three areas in the 5-month period was 434,397 hopper tons.

TABLE I.

Quantities Dredged from Barking Reach, Gravesend Reach and Tilbury Tidal Basin.

July—November, 1955.

Month	Quantities Dredged, in hopper tons		
	Barking Reach	Gravesend Reach	Tilbury Basin
July	2,004	37,753	15,925
August ...	13,696	23,047	1,050
September ...	37,403	29,856	50,748
October ...	nil	78,691	1,500
November ...	nil	92,589	50,135
Total, for 5 months	53,103	261,936	119,358



(By Courtesy U.K.A.E.A.)

Fig. 3. Underwater Injection Apparatus for Thames Experiments.

Results.

The most important and significant results of the experiment are summarised in Fig. 4, which illustrates clearly the first movement of the tracer seaward with the ebb current immediately after injection, and shows that no further seaward movement was detected in the following weeks. It also shows the progressive and more gradual movement of the tracer up-river to the "Mud Reaches." The extreme landward and seaward limits of detected tracer movement are marked on Fig. 1.

The extensive tables of results which were prepared from the Geiger-counter surveys are included in the full report on the experiment[4] but space does not permit their reproduction with this article. It might however be mentioned that comparative measurements of the radioactivity recorded at various places and various times during the experiment were obtained by subtracting the background activities from the post-injection ratemeter readings and then correcting for decay from the time of injection.

Some information on detailed conditions in Gravesend Reach during the experiment is provided by the record on Fig. 5 of activities on a typical cross-section near Tilbury Buoy 24 hours after injection of the tracer. It can be seen that the high activity was confined to a fairly narrow strip near the middle of the navigable channel. By the 18th November all the readings in this area had fallen to near background level. It is worthy of note that Tilbury Tidal Basin was the only place where a substantial amount of activity could be detected in November, 1955, despite the considerable programme of dredging (see Table I) which had been carried out there.

Comments and Conclusions.

The results, combined with the experience of the observers, in-

Radioactive Tracers in the Thames Estuary—continued

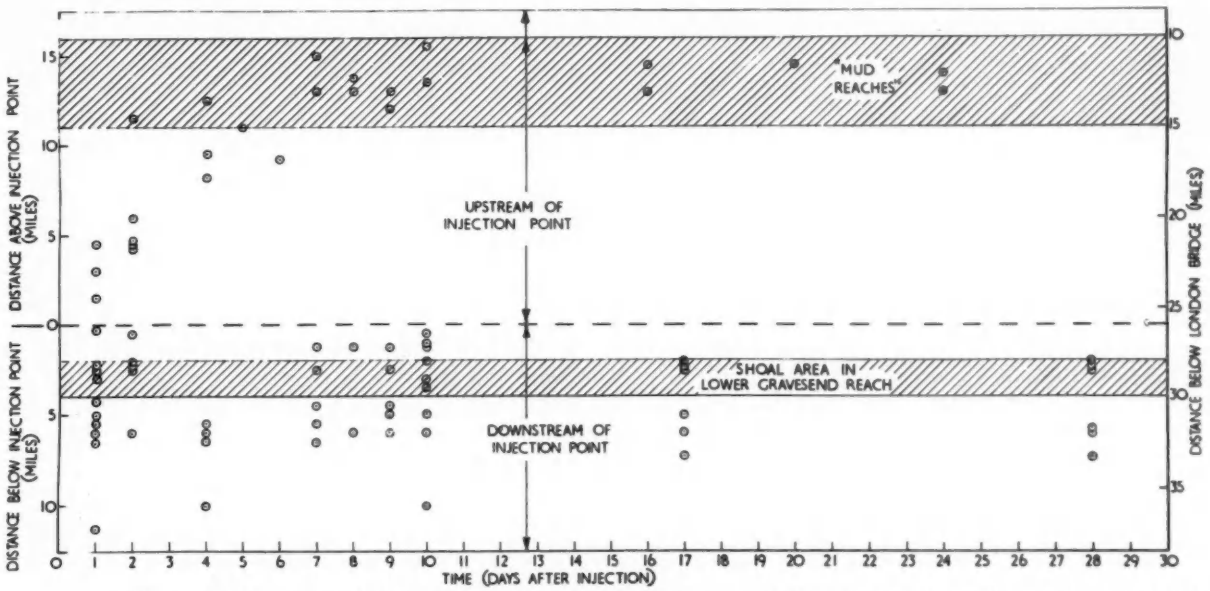

"MUD REACHES"
UPSTREAM OF INJECTION POINT
SHOAL AREA IN LOWER GRAVESEND REACH
DOWNSTREAM OF INJECTION POINT
DISTANCE ABOVE INJECTION POINT (MILES)
DISTANCE BELOW INJECTION POINT (MILES)
DISTANCE BELOW LONDON BRIDGE (MILES)
TIME (DAYS AFTER INJECTION)

Fig. 4. Positions where significant increases in radioactivity were recorded on the bed of the Thames Estuary after injection of tracer on 5th July, 1955.

dicate that the design and execution of the experiment left little to be desired. Throughout the experiment high activities were recorded only in the presence of mud, showing that the size distribution of the scandium glass was suitably chosen. The certainty with which the tracer was detected at distances of up to 15 miles from the injection point, and for over 4 months (or 1½ times the half-life) after injection, justified the decision to use a total activity of nearly 30 curies. The instrument proved to be extremely reliable in use and to require very little servicing.

The scandium glass particles, mixed with mud and deposited on the bed of the estuary, were free to move in several ways. It appears, from the ease with which they were followed, that the majority remained—as it was intended they should—in association with the layer of concentrated mud, or fluid mud, immediately above the bed, travelling with this mud and acting as a true indicator of natural movements. Travelling in this way, some particles were first deposited downstream of the injection point, and others were deposited upstream. It seems almost certain that some of the particles which in the first instance were deposited downstream were later carried upstream and re-deposited. Deposited particles were liable to be covered by further deposits of labelled mud or of inactive mud, and so to be involved in the natural process of consolidation by which a settled fluid mud layer becomes part of the true bed. During this process the radiation reaching a Geiger-counter detector on successive days, from a particular patch of mud containing an unknown number of radioactive particles, might be reduced by a progressive increase in the depth of consolidated inactive mud overlying the tracer particles. This reduction could not be determined. It also seems probable that an appreciable but unknown proportion of the tracer was removed by dredger from the zones of mud accretion during the course of the experiment. Furthermore it is to be expected—though this could not be confirmed by observation—that a small proportion of the finer tracer particles were dispersed in true suspension in the main body of estuarine water; some of these might later have been deposited in the mud zones, but many would have been carried gradually seaward by the net drift in the upper layers and eventually flushed from the estuary. For all these reasons—and also because it was impracticable for more than two boats and Geiger-counter teams to be made available for measurements—it was not possible to obtain many quantitative results from the experiment. However, the experiment yielded a number of significant qualitative results of interest and importance.

The tracer was carried seaward by the ebb current immediately after injection and deposited at low water at various points between Gravesend Reach and Canvey Island. After the first day, no evidence was found to indicate any further seaward movement of the tracer. The tracer was detected at a number of places between Gravesend and Barking in the course of its subsequent up-river excursion under the influence of the net landward bed drift. It is suggested that this upstream movement of the tracer took place in association with the normal upstream movement of a large patch or layer of fluid mud, the existence of such patches having already been demonstrated by normal sampling methods. The tracer reached the Barking siltation area about one week after injection. Previous observations with current meters, in the river and in the Thames Model, had shown that under low river flow conditions the Barking "Mud Reaches" constitute the upstream limit of the net landward drift near the bed, the reaches above this zone having

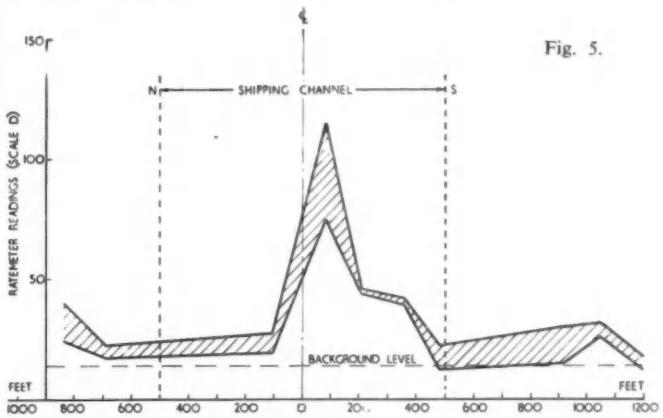


Fig. 5.

a net seaward drift at all depths. This view was supported by the fact that no indications of the tracer were found upstream of the "Mud Reaches."

It has already been mentioned that the level of radioactivity attained in the Barking area was only twice the background reading. It is therefore of particular interest to note that, despite the continuous siltation taking place there, this level of activity remained almost unchanged in the "Mud Reaches" throughout the experiment. The same was true of Tilbury Tidal Basin, though the level of activity there was somewhat higher. In both areas a considerable amount of dredging was carried out during the experiment; and it must also be remembered that the natural process of radioactive decay continuously reduced the activity of the tracer.

Radioactive Tracers in Thames Estuary—continued

It is clear, therefore, that the activity in the "Mud Reaches" and in Tilbury Tidal Basin must have been continually replenished in order to maintain the ratemeter readings. It is considered that the source of this replenishment was the portion of tracer which had been deposited downstream of the injection point on the first day of the experiment—mainly in the shoal area in Lower Gravesend Reach. The material so deposited was gradually removed by the landward bed drift, some of it being carried into Tilbury Basin and some being carried up to the "Mud Reaches."

As a result of the experiment it was concluded:

(i) that mud in suspension near the bed deposits and consolidates on the bed in the shoal area in Lower Gravesend Reach, in Tilbury Tidal Basin and in the Barking "Mud Reaches";

(ii) that, under low river flow conditions, mud in suspension near the bed in Gravesend Reach is transported up-river by the landward bed drift as far as the Barking "Mud Reaches" where it deposits and consolidates;

(iii) that, under low river flow conditions, there is no evidence to show that mud in suspension near the bed in Gravesend Reach is evacuated from the estuary, either in the course of the immediately succeeding tides or during a period of three or four months.

This article is concerned only with the experiment carried out with radioactive tracers in 1955, and with the direct conclusions which may be drawn therefrom. The wider implications of these conclusions, and their relevance to the general problem of silting and dredging in the Thames, must be considered in relation to the other research being conducted on the river and in the Thames models.

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Protection Works on the Mexican Coast

The Creation of Beaches and Dunes

By MANUEL DIAZ-MARTA

THE Veracruzian Coast, known for its fine long beaches, of which a transversal profile of the Tuzpam beach is typical, is shown in Fig. 1. These beaches are almost continuous over a zig-zag coastline and consist of fine sand. It will be observed that the sea-bed has a very wavy profile showing depressions between the sand bars lying just off-shore. The beaches are very flat with an average slope of 1 in 75, and the tidal range is small. In times of storm these sand bars often change their position, particularly when the seas approach the beach obliquely and there is a temporary depletion. This condition however does not last for long, and the beaches normally are soon made up again.

Movement of Sands During Storms.

Under wave action in fine weather, the movement of fine materials on the sea-bed of Vera Cruz is usually towards the coast, but just as usually, in stormy weather, it recedes before an onshore wind. Naturally there are exceptions to this more common cycle, and the degree of physical change varies considerably. Sometimes a beach is unexpectedly built up, or depleted, under phenomena which appear to be the seasonal normal, yet the result may be contrariwise. However, it can usually be taken that long waves will replenish a beach and high waves and onshore winds will deplete a beach on this coast.

One can only guess in what direction and how far the depleted material is carried out to sea and deposited; and likewise one can only guess from what source the replenishing material may come. In this connection, from frequent underwater surveys carried out over the run of the submerged oil-pipe lines, it has been verified that waves of 2 to 3.5 metres high remove the sand about the pipes in depths of 3.0 m., and deposit it in depths of 3 to 5.5 m. As the calculated volume so deposited is usually less than the calculated erosion, it is probable that a considerable amount is deposited further afield.

Careful surveys of the submerged pipe lines on the beaches and foreshores of Tuxpam have been recorded for over 18 years, and it has been noted that in depths of over 6.7 m., the oil pipes lying on the sea-bed are only very lightly embedded. It therefore appears that at this depth there is little or no deposit. On the other hand, in lesser depths the pipes are usually covered with layers between 30 cms. and 1.20 m. and the formation of the deposit is characteristic of that left by groyne action. In the deeper water the movement is also continuous and encourages the formation of banks or bars which at times grow to considerable size. Under the turbulent sea action during gales these banks are highly vulnerable and are often swept away completely and rapidly. The direction in which the sands of the eroded banks move is in no wise constant and in fact can not always be predicted even with full information of the elemental conditions.

Even if the material forming the beaches is being constantly renewed, a beach subject to a phase of erosion by the sea and wind may not gain sufficient replenishment. This could happen if there were a lack of material on the sea-bed in the direction from whence the seas and wind come. On the other hand if material is in good supply on the sea-bed and the wind is off-shore it is highly probable that the beaches will accrete well.

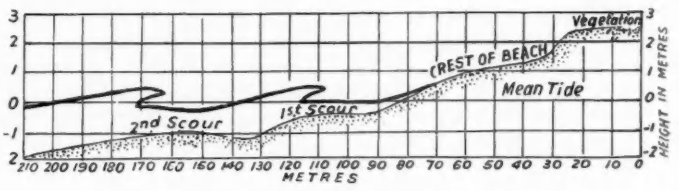

Fig. 1. Transverse profile of beach at Tuzpam.

Movement of the Sands on the Beaches of Vera Cruz.

In general the action of the waves is much more important than the direction of the wind in the formation and erosion of beaches: nevertheless, in those places where the sands forming the beaches are fine and the winds are strong and persistent the transport of sand by the wind is of great importance in the modelling of the beaches, and of the building up of the (border) dunes fringing the coast. During some storms the movement of the sand on the beach at Mocambo (Fig. 2) has been observed with a view to the execution of future works of defence and maintenance of the beach. To the south of this place the river Jamapa enters the sea and contributes its share of sand load, whilst to the north there lies the Medano (sand-hill area) of Mocambo together with other eolitic formations of less importance. To the north-east, in the sea, there are the reefs or submerged banks of growth of madre-

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pore (perforated coral) better known here as "muca." This rock-like formation continues right up to the front or toe of the sand beach of Mocambo. In this popular resort, well frequented by bathers, the beach is constituted of a thin layer of sand resting upon the "muca."

Seven years ago the sandhills of Mocambo were planted with vegetation. Since that time the beach at the Balneario (bathing station) of Mocambo has gradually attenuated, most probably by reason of the growth of this vegetation, as formerly the strong

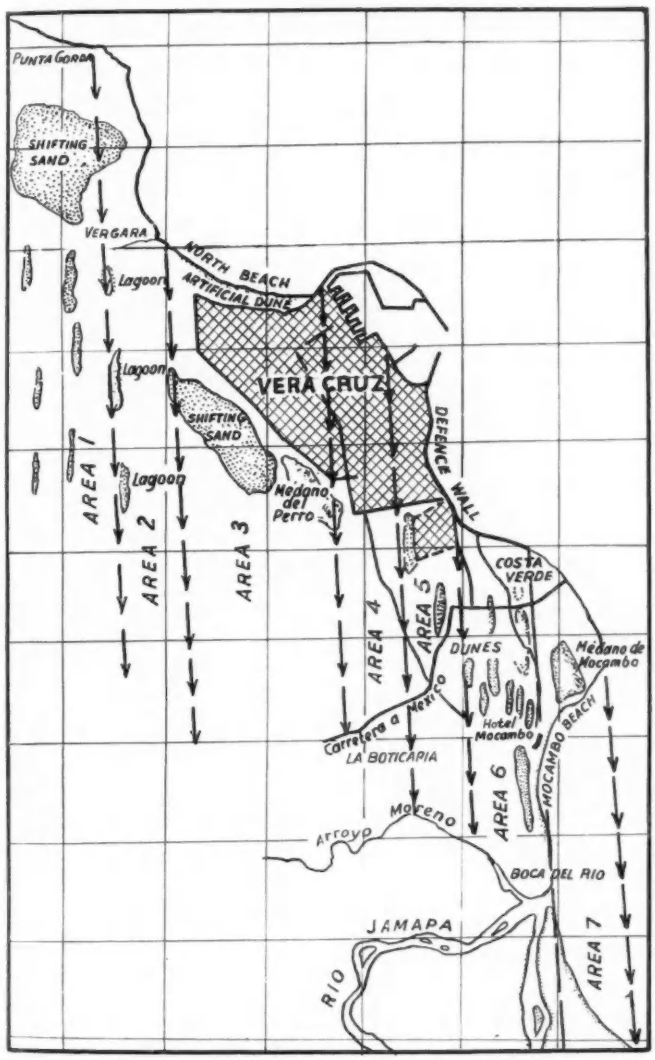

Fig. 2. Influence of the orientation of beaches in the leeward zones.

northerly winds blew considerable quantities of sand from the arid hills into the sea and along the beach front: note the lines of beach in Fig. 3.

The madrepore rock on which the beach layer lies remains clear of sand just below Low Water, and in times of gales the seas not only sweep the beach away but invade the dry land and cause damage to the roadways, buildings and much of the considerable area of decorative trees and gardens. To re-establish the beach in its former stable condition it was necessary to restore the equilibrium of sand supply and depletion by other means than depending upon transport by the wind from the sandhills to the beach. The remedy eventually carried out consisted of a system of groynes (see Fig. 3).

The groynes were constructed of quarry rubble 5 cwt. to 1 ton in weight. The main groyne was placed at the northern end of the bathing station with a dog's leg alignment over a ridge of madrepore, which itself already gave some measure of protection. The three other groynes were shorter, spaced at variable distances to enclose a total length of beach of 700 metres. Before and after the construction of the groynes it had been confirmed that the more gentle and persistent winds coming from the south favourably replenished the beach, as much from the more regular sea action as from the fact that, coming from the estuary of the river Jamapa and the well supplied contiguous beaches, they impelled the transport of material.

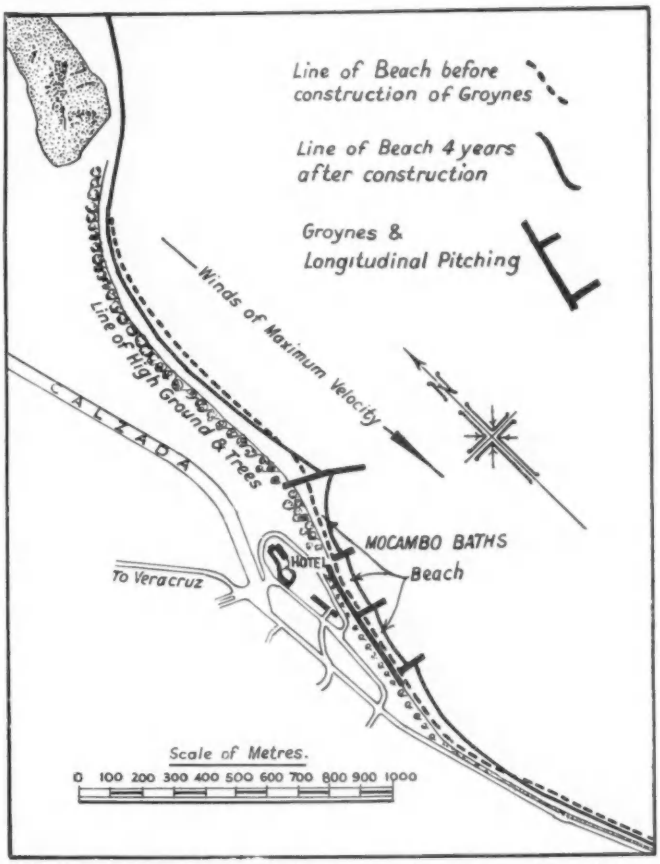
Line of Beach before construction of Groynes
Line of Beach 4 years after construction
Groynes & Longitudinal Pitching
Winds of Maximum Velocity
Line of High Ground & Trees
CALZADA
MOCAMBO BATHS
HOTEL
Beach
To Veracruz
Scale of Metres.
0 100 200 300 400 500 600 700 800 900 1000

Fig. 3. Mocambo beach showing groynes of quarry boulders; dotted line extent of beach before constructing groynes and solid black line after construction.

On the other hand, the winds and seas from the north were much more violent and originated in places (relative to Mocambo), devoid of transportable material, so that the beaches were depleted.

Two years after the construction of the groynes a remarkable extension of the Mocambo beach was noticeable compared with its previous grave state. The increase of the thickness of sand on the rock understratum was so substantial that although the storms of the following winter eroded considerable quantities of sand, they did not uncover the rock nor put into danger the bathing station installations or dry land amenities as formerly. At the time of writing, the works have not only succeeded in restoring the beach but also have built up a more spacious area of sand than was there originally.

Tidal Currents and Littoral Drift.

Offshore in the vicinity of the coastal defence works submarine surveys of the sea-bed by echo sounding have been carried out, and it is of interest to record that we can confirm the conclusions of Dr. van Veen regarding the general shape of migrating sand-banks on the sea-bed under the influence of the ebb and flow of the tides. The forms and profiles of the banks are distinct indications of the tendencies of the direction of flow of the tidal currents over the sea-bed, but they are not always co-incident with those of the surface.

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On the Veracruzian coast the oblique incidence of the waves predominates over the tidal current. The greatest intensity of the wind and the greater lengths of fetch, lie in the north-west to north sector; the most severe gales actually occur within the sector north to north-north-west. The drift of sand takes place in distinct phases, but the predominant depends upon the time of action and the force and obliquity of the seas, so that the general drift is actually the resultant of a combination of forces of varying strength and direction. The cause of the special configuration of some coasts (like the Veracruzian) and the sea-bed in its vicinity, is apparently due to a general drift in one direction and a contrary local drift in another.

As Minikin in his book on "Coast Erosion and Protection" points out: the particle movement on a sea-bed is not continuous but takes the form of an erratic succession of forward and backward movements which eventually, over a period of time, results in a gain in any one direction. Thus it will be appreciated that the sum total of the activity under the forces of the natural elements is somewhat fortuitous and cannot be foreseen. There are, however, in beach-building, as we have been able to prove by experience, certain conditions that one must observe to escape the hazard of failure. An example is the siting of a new sea-wall projected to protect the Marine Promenade and Road of Vera Cruz. For convenience and aesthetic considerations, the alignment of this wall was sited very close to the existing high water line, leaving only a narrow strip of beach. Indeed, short lengths ran on the seaward side leaving, at high water, no beach at all. Eventually, when strong erosion took place at these weak points, the foundations were impaired and the wall was forced seaward. Remedial measures were undertaken by dumping rubble at the face to a slope of 1 in 3 and driving a line of sheet piles on the landward side to prevent the loss of sand fill. At the time of writing the remainder of the wall has proved quite stable although it is placed rather too close to the original high water line. In the author's opinion, before the construction of the wall, the stability of the beach was as much due to the transport of sand by the wind as to deposit by the sea. As for the sea-wall, it was found to act as a barrier to the flight of dry wind-borne sand, and caused a considerable percentage to fall on the beach at the foot of the wall; thus preventing it invading the land.

This action was distinctly evident on the beach at Costa Verde where the wall was constructed of reinforced concrete sheet piles anchored back.

THE ACTION OF THE WIND ON THE COASTAL LANDS OF VERA CRUZ

The Sandhills of Vera Cruz.

In the formation of the Veracruzian coastal lands the supply of sand by the sea to the beaches and its transport by the wind to the interior is of great importance. The sea constantly feeds the sand to the beaches, and the strong winds from the north to north-west drive the surface dry sand from the upper beaches and form hillocks and depressions inland of diversified form. In Mexico for convenience of mapping, the land strips fed from certain sections of the coast are called "Faja." In the vicinity of Vera Cruz the faja reach a length that varies from 8 to 10 kilometres considering only the distance in which the wind is the predominant factor, since, more inland, the rains and vegetation dominate the configuration of the countryside.

The topography of the country beyond the wind dominated area shows eolitic formations formed in past epochs and now dormant and overgrown.

For example faja (Fig. 2) observed from the air shows the coast line almost normal to the winds (direction) of maximum velocity and the process of formation of these sandhills. From the beach one notes banks of sand oriented lengthwise in the same direction as the north and north-west mean. One notes too a zone of vegetation, but only very sparse, which stretches for about 2 kilometres from the coast. Beyond this there occurs a large dune totally arid and in continuous movement. The surface on the wind side of these arid dunes undulates with an appearance of scales. These scars are made by winds of moderate strength; on the other hand, strong winds make them larger and form high inclined planes and furrows. Then the rain rounds off the sharpness of the wind impressions to the characteristic form.

The sands are impelled by the wind up the weather slope of these arid dunes to the crests where strong eddies and vortices of air whirl about and the particles in suspension are in part thrown on the lee slope, and in part carried further afield in the general direction of the wind. In consequence of the new deposits on the lee slope the crests are continually being advanced. It is this change of form and position which is so apparent.

These arid dunes reach considerable heights, up to 35 metres, and establish on the immediate lee relatively calm zones in which vegetation flourishes. The frontal ground of the active dunes is often covered by a series of hillocks or elongated ridges extending in the direction of the north, north-west wind, separated by valleys oriented in the same direction. This zone of sandhills appears as though combed in the predominant wind direction when seen from the air. Strong winds which blow in other directions do not appreciably alter the appearance, and the sandhill formation, under purely natural conditions, for a distance of 8 kilometres from the coast, remains unaltered as above described.

Influence of the Orientation of the Beaches in the Eolitic Formations to the Leeward.

It is curious to observe how the fringes of the fajas which commence at the beaches similarly oriented hold almost identical characteristics (Fig. 2). In the zig-zag which forms the outline of the Vera Cruz coast, each beach oriented in the direction east to west, almost normal to the winds of maximum velocity creates a sandhill zone very similar to that described above. The moving arid dunes appear at distances which vary between 2.5 to 3.5 kilometres from the coast and this phenomenon is repeated in such a manner that the arid dunes reproduce the form of the zig-zag coast line.

In the stretches of the coast oriented more or less north to south, the appearance of the strips of ground bordering them are very distinct, the original arid zones being covered with vegetation even up to the beaches. From the air one can observe the lots devoted to pasture nearly up to the sea in the east direction, whereas to the north, the limit is 2 or 3 kilometres from the beaches.

The Mocambo beach has approximately the direction north-south and is, moreover, protected from the northerly winds by nearby heights. With such orientation, plantation of trees, etc., for the embellishment of the resort is possible close up to the dry upper beach. The behaviour of the north-south beach is very different from that of the east-west front across the winds of maximum velocity, these winds supply hardly any windborne sand. In effect the northerly winds are already weakened by the immediate hillocks at the beach, and instead of picking up the sands of the sea they drift them in a parallel direction to the limiting zone of the water, and after a while increase the water-level and the wave height and thus the send of the breakers up the beach. This action wets the dry sand and impedes its removal. The "whip" of the sands is therefore weak and does not prevent the growth of vegetation.

It will be appreciated that these beaches do not release sand for the zones to the leeward. We have observed, yet without systematic proof, that the land behind them appears to be at a lower level and the low ground and small lakes are all elongated to the leeward of these stretches of beach, as will be seen in fajas Nos. 2, 4 and 7 (Fig. 2). Thus behind the beach of Vergara the depressions and lakes are oriented very like those behind the beach of Mocambo, although the latter is not protected by nearby high ground.

In faja 4 the northern end is now fully occupied by modern city buildings, and the quays and harbour wall of the Port of Vera Cruz; until recently this area was swampy and at a low level, whilst the original coast line ran approximately north-south. To the north of the city the beach holds an orientation north, north-west, without any large variation for some 30 miles north of Tuxpam.

As this orientation is that of the winds of maximum velocity, the formation of the sandhills have less importance than those in the fajas of the coast about Vera Cruz and in those which follow towards the south of this port. Observed from an aeroplane one

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see large stretches in which the vegetation reaches almost to the coast. On occasions, one notes a single cordon of sand of appreciable height immediately alongside the beach which, not having received the full force of the wind charged with sand, has been able to support vegetation. In the stretches where the beach lies east-west one notes a faja of sandhills of some greater depth. These features are to be seen on the coast between the Nautla and the Tecolutla. The high road runs to within a short distance of the coast and one notes more than one cordon of sandhills. In general these are covered with vegetation, yet have little importance as the sand does not invade them.

On this same coast north of Vera Cruz, when the orientation of the coast tends more towards the west, as is the case north of Punta Delgada, the same features occur as on the coast of Vera Cruz. The salient in the sea terminates in a mountainous cordon and limits beaches which face relatively to the north. The currents of air drift and lift the sands that form several sandhills and in flight, once transported over the elge of the cape, they fall into the sea. To the south of these irregularities one does not come across the same aridity, the land remains protected from the strong winds and with the vegetation produce an agreeable countryside. However it is also subject to the same topographical movements as occurs at Mocambo already described.

Topography of the Sandhills.

Aerial photographs and plans of the topographical surveys show that the sandhills are sometimes more than 30 metres high, as, for example, in the Medano of Perro and close to the Boticaria high road. In the salient between Cost Verde and Mocambo the greatest heights are 20 to 25 metres, and the depressions between the dunes 2 to 3 metres. The slopes of the sides vary considerably; one encounters frequently slopes of 29 to 32 degrees; in general, the windward slope is less steep than the leeward. Sometimes there occurs what appears to be extraordinary phenomena, nevertheless these are easily explained. The wind sometimes strikes the artificial dunes, which are very close to the sea, obliquely and scours out the lower levels of the dune giving it a temporary side slope steeper than the natural angle of repose: after a while, the natural adjustment is made by a slip of the upper layers.

Artificial Dunes.

Maritime constructions, road-making, urbanisation, the planting of trees, and various forms of agriculture modify in great measure the damaging effect of the northerly winds over the City of Vera Cruz. Even so, in this area, artificial dunes and the planting of vegetation have been the main remedies against the invasion of wind-borne sands.

To form artificial dunes barricades are erected on the surface to lessen the direct effect of the wind on the sand particles. This takes the form of a fencing of rough sawn timber or sawmill remainders of wattles secured to posts driven into the ground. The wind on encountering these obstacles deposits sand against the fences. A ridge or hump grows up relatively quickly and the crest displaces itself as if pushed forward by the wind. This is because the sand is precipitated in large quantity after passing the barricade rather than in front of it. The principal labour of formation and maintenance consists of withdrawing and re-erecting this fencing at a higher level on the newly created slope. The artificial dunes which defend Vera Cruz occupy a length of more than 1 kilometre between the North Beach and the By-pass road.

The first dune is established very close to the sea but in course of time it travels forward leaving a wide strand behind it from which the wind carries the sand over the obstacle. Eventually this dune also becomes too far from the sea to have any effect in retaining the particles in movement. In that case a new dune is formed by erecting another palisade close to the sea. At the same time branches are placed or vegetation is planted on the first dune (Fig. 4a). The new dune forms and increases more rapidly than the first (Fig. 4b) and again it becomes necessary to form another dune close to the water, and plant the other.

In a northerly gale (1952-1953) we observed the behaviour of the dunes over several successive days. The hurricane force of the winds drifted the sands of the beach of some 15—20 metres width and lifted them up the steep slope of the first dune and in its passage up the talus picked up the surface sand also. The squalls of ascending air on reaching the fence encountered other squalls and caused dense vortices of suspended sand which was deposited about the obstruction.

The following day it was recorded that the beach from which the sand was blown had entirely disappeared and the water line had encroached to the foot of the seaward dune. On the second day the wind abated and it was found that the slopes on the land side were 29—33 degrees and on the seaward side 32—34 degrees. On the seaward slope several areas showed humps of sand well above the critical slope profile. The humps little by little resumed a normal inclination. The crest of the sandhill had moved considerably landward, and heightened, whilst the old crest and its fencing had disappeared.

After two days of the north wind the slope on the seaward side had lost on the average 50 cms. thickness. The vertical fences running transversally up both faces with the aim of reducing the force of the winds of oblique incidence were all destroyed after the third day of the storm. One curious effect worth noting was that a single heavy post driven into the beach a few days before the commencement of the storm had, in three days, created a small hillock about it no less than 1.5 m. high. The wind dropped after 4 days and left few of the fences standing and those were in a half ruined condition on the seaward slope, whilst the first dune was entirely flattened.

In the succeeding calm weather the beach soon re-established itself, in fact, it was broader than before and the first sandhill was

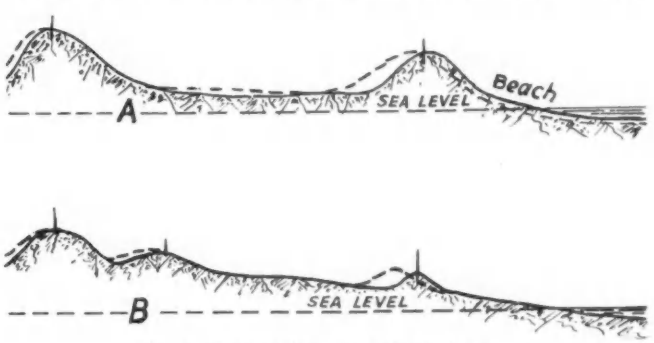

Fig. 4 Construction of artificial dunes.

now 4—5 metres further away from the sea water-line. The inland dune was replaced also but to a lesser amount, although it was covered with firmly rooted vegetation.

An important point arises from these phenomena in that they demonstrate the wisdom of siting roads and structures well out of the range of the sea action in areas which require the protection of artificial dunes.

The sand moves in part suspended in the air and in part swept from the ground surface and is displaced forward by the air stream. To counteract this tendency it is important that obstacles are provided to prevent a direct run of the air current over any extensive surface. It is also important that the first dune should remain near the water line so that a minimum amount of sand will be extracted from the beach. It also should be saturated with water by the tide. Parallel dunes should be as close together as practicable to lessen the extent of the intermediate valleys between them and thus prevent the loss of sand. It has been shown in Fig. 4 that the second dune, although planted with deeply rooted growth, still loses some sand. Further losses should be prevented by the planting of trees.

In synthesis, artificial dunes retain sand but do not require, as do the natural dunes, a depth of border land 8 kilometres long. When properly placed and maintained with adequate fencing, an efficient length of land need extend no more than 400 metres from the beach.

(To be continued)

R. R. M.

Electrical Distribution as applied to Docks

Section II. The Distribution Layout

By C. H. NICHOLSON, M.I.E.E., M.I.Mech.E., F.R.S.A.

(Continued from page 260)

The High Voltage System

On a dock area as shown in Fig. 1.1 (see previous issue) two high voltage feeder arrangements may be considered.

(a) Duplicate Radial Feeders.

(b) A Ring Main System.

The advantages and disadvantages of these are tabulated below.

(a) Duplicate Radial Feeders

Advantages	Disadvantages
Control from one central point of all substations is possible without addition apparatus in the form of remote control gear.	Costly and utilisation of cables and switchgear is low owing to the fact that one feeder must be capable of carrying the full load. Feeder diversity cannot be taken advantage of.
Protection against fault conditions is more easily accomplished and therefore the protective gear may be less complicated.	Switchgear. Cost high.
Greatest insurance against shut down.	

(b) Ring Main System

Advantages	Disadvantages
Can be designed to give reasonable insurance against shut down, together with good utilisation of cables.	The protection against inadvertent shut down under fault conditions is more difficult than (a) and may involve the use of pilot cables.
Cable and switchgear costs lower than (a).	

The Ring Main System is thus suitable for dock distribution and is shown schematically on Fig. 2.1 the number of circuit breakers and cable length being less than for a radial feeder system.

On the question of reliability, in the event of any one section of the H.V. feeder failing, the substation involved may be fed from the other side of the ring i.e. referring to Fig. 2.1 upon a fault occurring between No. 1 and No. 2 substation, opening circuit breaker B at No. 1 substation and circuit breaker C at No. 2 substation will clear the fault from the Ring Main System and at the same time allow No. 2 substation to be supplied from No. 1 substation through the circuit breakers A, H, G. F, E. and D.

The size of the H.V. cables may now be assessed from a consideration of the loads obtained from the power required to operate the various items of plant, and it will be necessary to convert the kilowatt demand, after load diversity has been allowed for, into Kilovolt amperes (K.V.A.) demand and in order to do this a power factor of .8 at each substation, unless there are particular circumstances producing abnormally low power factors (see Table 2.1), may be assumed. If, however, power factor correction at each substation is provided a power factor of .9 may be assumed, this question being fully dealt with under section "Power Factor Correction."

$$\text{K.V.A.} = \frac{\text{K.W.}}{\text{Cos}\theta}$$ where Cosθ = power factor as a decimal (2.1) and

from $I_L \frac{\text{K.V.A.} \times 10^3}{\sqrt{3}E}$ the load current may be calculated (2.2)

In the event of a fault between substations requiring operation with the ring main system open, each leg of the ring main must be capable of carrying the full load current of the maximum number of substations in service on one leg of the main. Using the example of the distribution system shown in Figs. 1.1 and 2.1 the maximum number of substations under fault conditions is three, the maximum load after allowing for load diversity being 2020 K.V.A.

Table 2.1

Electrically driven plant power factors (utilising Induction Motors)

	Power factor as a decimal	B.H.P.
Capstans	.75/.8	20/25 B.H.P.
Cranes	.7/.8	40/150 B.H.P.
Conveyors	.75/.8	40/150 B.H.P.
Welding Plant	.35	Any capacity
Pumping Plants	.85/.88	100/1000 B.H.P.
Pneumatic Grain Elevators ...	.85/.88	
Incandescent Lighting ...	.98	

Gaseous Discharge lighting .5/.6 increased to .85/.9 by the use of Capacitor power factor correction.

Note—The power factors are for fully loaded plant, where plant is operated at below full load the power factor is reduced and reference should be made to Table 10.3 in Section X "Power factor correction."

The number and location of the Substations is the next consideration from which Fig. 1.1 has been produced. In general the number and location of the substations is defined to a large extent by the magnitude and position of the loads of the groups of plant, the current and consequent voltage drop in the L.V. distributors being to a great extent the deciding factor. It is not economical to transmit large blocks of power at L.V. over large distances, the word large now referring to L.V. distribution, and a rough rule is that a voltage of not less than 1000 volts is necessary for reasonably economic transmission over 1 mile thus on this basis L.V. transmission at 415/440 volts 3 phase A.C. is limited to one half mile approximately. The factors affecting the distance of transmission for L.V. dock systems are thus somewhat different to those affecting the H.V. cable layout insomuch that whilst in the latter, the voltage drop is negligible, it is of major importance on a L.V. system, this being illustrated under the heading "L.V. cables," by a worked

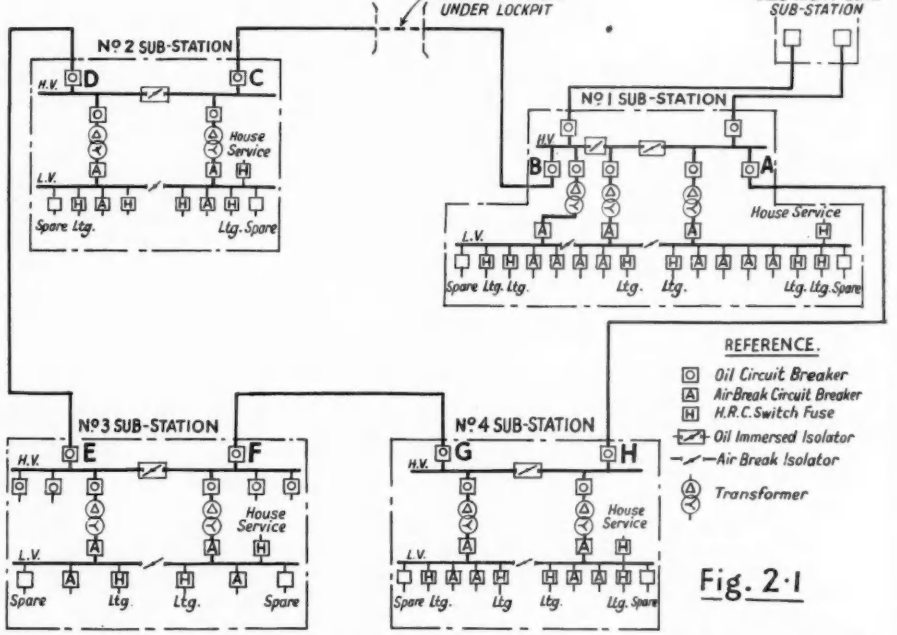

Fig. 2·1

Electrical Distribution as applied to Docks—continued

example in respect of the L.V. cable layout shown in Fig. 1.1.

The substations should always as far as possible be sited at the centre of gravity of the load as this ensures the minimum voltage drop on all distributors the procedure being as indicated below:

Let L_1, L_2, L_3, L_4, L_5 etc. represent individual loads in kilowatts and X_1, X_2, X_3, X_4, X_5 etc. represent the distances of these loads from any two fixed lines OX and OY at right angles to one another.

The "Centre of Gravity" is the point of intersection of the distances

$$X_o = \frac{X_1L_1 + X_2L_2 + X_3L_3 + X_4L_4 + X_5L_5 \text{ etc.}}{L_1 + L_2 + L_3 + L_4 + L_5 \text{ etc.}} \text{ from OX} \quad (2.3)$$

$$\text{and } Y_o = \frac{Y_1L_1 + Y_2L_2 + Y_3L_3 + Y_4L_4 + Y_5L_5 \text{ etc.}}{L_1 + L_2 + L_3 + L_4 + L_5 \text{ etc.}} \text{ from OY} \quad (2.4)$$

Fig. 2.2 indicates the distances for OY and OX and also the magnitude of the loads together with the substation site on the "Centre of Gravity." Example:

$L_1 = 100$ KW $X_1 = 200$ yds. and $Y_1 = 400$ yds.
$L_2 = 150$ KW $X_2 = 400$ yds. and $Y_2 = 300$ yds.
$L_3 = 250$ KW $X_3 = 100$ yds. and $Y_3 = 200$ yds.
$L_4 = 50$ KW $X_4 = 500$ yds. and $Y_4 = 200$ yds.
$L_5 = 200$ KW $X_5 = 300$ yds. and $Y_5 = 100$ yds.

$$X_o = \frac{(200\times100)+(400\times150)+(100\times250)+(500\times50)+(300\times200)}{100+150+250+50+200}$$

$= 253$ yards from OX (dotted line ox)

$$Y_o = \frac{(400\times100)+(200\times150)+(200\times250)+(200\times50)+(100\times200)}{100+150+250+50\times200}$$

$= 220$ yards from OY (dotted line oy)

The centre of gravity is at the point where ox and oy intersect.

Having sited the substations at the approximate centres of gravity of the various group loads as in Fig. 1.1 the actual layout of the substations may now be considered. Commencing with No. 1 substation, which is the main substation and switching point for the ring main, the total K.V.A. to be converted from 11,000 volts to 415 volts 3 phase 4 wire giving a 240 volt lighting service is 2,340 K.V.A. (see under Estimation of Power Requirements) and Fig. 1.1, thus to allow some margin for extension a transformer capacity of 3,000 K.V.A. is visualised. Two 3,000 K.V.A. transformers would meet the case, one 3,000 K.V.A. being standby but this is obviously uneconomical as one 3,000 K.V.A. transformer is at all times out of use. A better and more economical arrangement is the provision of three 1,000 K.V.A. transformers giving one 1,000 K.V.A. transformer as standby. A further reason against the use of two 3,000 K.V.A. transformers is the increase in the prospective L.V. fault level necessitating an increase in the rupturing capacity of the L.V. switchgear.

The prospective L.V. fault level may be estimated upon the assumption that the H.V. fault level is in the order of 250 M.V.A., the L.V. fault level is

$$\text{M.V.A.} = \frac{\text{Transformer M.V.A.} \times 100}{\%\text{impedance}} \quad (2.5)^*$$

where M.V.A = Symmetric fault mega volt amperes.
%impedance = Transformer impedance.

thus taking the tranformer impedance as 4.5% (see section "Transformers" Table No.) the M.V.A. fault level =

$$\frac{1000\times100}{4.5} = 22.25 \text{ M.V.A. for a 1,000 K.V.A. transformer}$$

and 66.75 M.V.A. for a 3,000 K.V.A. transformer.

The above indicates the desirability of using three 1,000 K.V.A. transformers and thus reducing the required rupturing capacity of the L.V. switchgear to 25 M.V.A.

The general arrangement of a substation suitable for a dock installation is given in Figs. 2.1 and 2.2, general practice being to use outdoor transformers of the oil insulated self cooled type. The switchgear may be any of the types indicated in Section IV "Switchgear" due regard being paid to the duty required, the importance of the substation, and the economic factors involved e.g. a small isolated substation at the end of a long sub feeder and thus having a relatively low M.V.A. fault level could with advantage be provided with cheaper switchgear such as fused interlocked isolators either of the direct fuse operating or the fuse trip type. From an economic point of view this course would be particularly desirable if the total yearly output was small. On the other hand a substation having a large yearly output, serving important plant and thus requiring a high level of fault discrimination in order to minimise plant shut downs will require more expensive and comprehensive switchgear, H.V. oil circuit breakers with discriminating relays together with L.V. air break or oil circuit breakers provided with overload and earth leakage relays are indicated.

***Table 2.2**

Maximum Transformer Rating permissible with L.V. circuit breakers

Transformer Rating	Transformer L.V. Circuit Breaker
750 K.V.A.	15 M.V.A. Rupturing Capacity
1000 K.V.A.	25 M.V.A. Rupturing Capacity
1750 K.V.A.	35 M.V.A. Rupturing Capacity

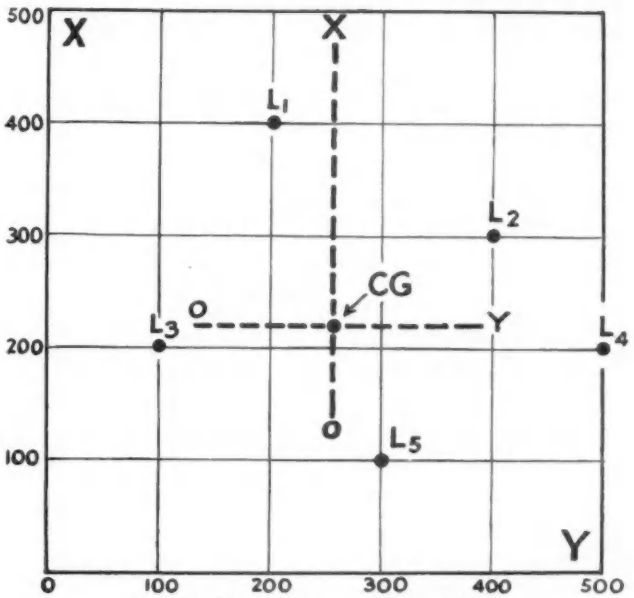

Fig. 2.2. Determination of C.G. of loads.

The Low Voltage System.

Under this heading the layout and size of the low voltage cables from the substations to the supply points from which secondary distribution is taken is given consideration.

Figs. 1.1 and 2.1 give the physical layout and also the schematic arrangement of the switchgear.

In general terms the service to each distribution pillar should be by cables of such size to enable the load to be carried should a cable fail unless the plant supplied with power from the particular distribution pillar is not sufficiently important to warrant the cost. The example of Fig. 1.1 indicates a third cable and is dealt with later in this section. Whilst the indication in Fig. 1.1 is that the third cable from the distribution pillar to the plug box or trolley wire main is a tapping all such connections should be made through disconnectors in order that isolation can be readily made in case of fault, further when a relatively small service is taken from a heavy distributor adequate protection must be provided in view of the short circuit current which may be available under fault conditions. Also in all cases the ability of the small service cable to stand up to fault conditions must be investigated. The insurance against cable failure is one which can only be given consideration by an examination of the whole of the circumstances. Modern cables are in the main very free from breakdown and the cost of duplication must be balanced against the possibility of failure which to a great extent is dictated by the nature of the ground, i.e. whether subsidence is likely and also the actual site of the cable which to a great extent influences the chance of mechanical damage. As an

*H.V. impedance neglected.

Electrical Distribution as applied to Docks—continued

example a cable laid direct in the ground under a railway track is much more liable to damage than one laid in unused ground, on the other hand if the unused ground is subsequently used for the storage of heavy material then cable damage can occur due to subsidence. The use of interconnectors as shown in Fig. 1.1 at the Coal Conveyor site is a further means of affording insurance against cable breakdown.

The use of disconnection boxes installed in the ground may be used for affording means of making distributor connections but on account of the difficulties, both physical and maintenance, of ensuring water tightness, together with safety to the operator the distribution pillar has much to recommend it. Where site considerations allow distribution points should be sited near to the centre of the gravity of the load served and may be positioned by the same method as that indicated for substations. Where the plant consists of cranes or similar plant having large transient demands the

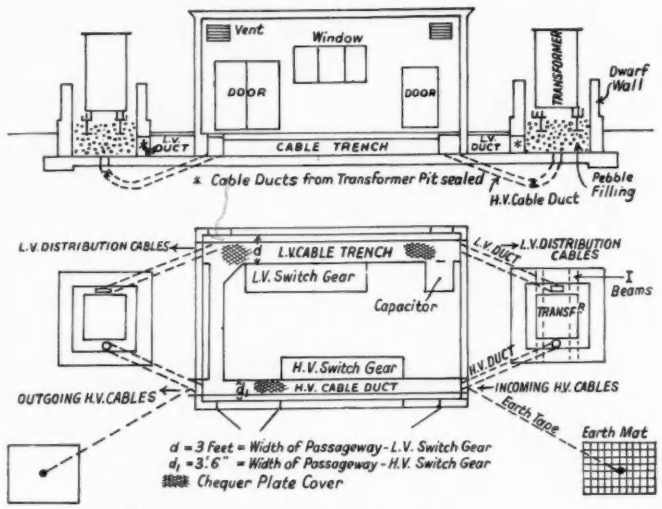

Fig. 2.3. Typical Layout of A.C. Substation.

use of contactor circuit breakers provided with "close" and "open" push button control with instantaneous and time lag overload protection gives good insurance against time loss due to transient faults, i.e. trailing cable damage, and also due to the instantaneous operation of the circuit breaker on relatively small fault currents (200% to 300%) damage due to fault current is reduced. Small services having more normal current characteristics can be adequately dealt with by means of high rupturing capacity fuses. In all cases distribution pillars should be provided with incoming and outgoing isolators. Overhead lines for distribution have not been considered in view of their relative unsuitability for dock installations, the small saving in cost and the increased maintenance.

Table 2.3

Fault currents corresponding to various M.V.A. and voltage ratings

Voltage	M.V.A.	Symmetrical amperes	Asymmetrical amperes	Peak amperes
400	5	7250	9060	18500
400	15	21600	27000	55000
400	25	36000	45000	91800
400	35	50600	63000	129000
440	5	6570	8210	16800
440	15	19700	24600	50200
440	25	32800	41000	83600
440	35	46000	57500	118000
6600	75	6570	8210	16800
6600	100	8760	11000	22300
6600	150	13100	16400	33400
6600	250	21900	27400	55800
6600	500	43800	54800	111700
11000	75	3940	4930	10100
11000	100	5250	6560	13400
11000	150	7880	9850	20100
11000	250	13100	16400	33400
11000	500	26300	32900	67100

Substations.

The Substation building must be fireproof and have adequate ventilation, the natural ventilation often being supplemented by extraction fans. It is most important that the ambient temperature is not excessively high as this will reduce the rating of all types of equipment due to the increase in the final operating temperature.

Modern practice utilises outdoor type transformers in order to reduce the size of the substation building and a further reduction is possible by the use of outdoor H.V. fused isolators for small isolated services. Adequate oil retaining dwarf walls should be provided around the outdoor transformer foundations in order to contain the transformer oil in the rare case of the destruction or rupture of the transformer tank under severe fault conditions. The sump thus formed may be filled with gravel or stone chippings in order to limit the duration of a fire. It is also convenient to increase the size of the enclosure so that the H.V. and L.V. switchgear may be similarly dealt with. Fig. 2.3 shows a typical arrangement for a dock substation and indicates the space required in the front and behind the L.V. and H.V. switchboards. It will be noted that two earthing electrode systems are shown, this subject being fully dealt with under Section VIII "Earthing." Whilst Section IV describes switchgear in detail the following summarised items are given in this section.

H.V. Switchgear 6.6 K.V. to 11 K.V: Dock installations taking an electricity supply at either of the above voltages, unless the system is small, should be provided with H.V. switchgear having a rupturing capacity at the supply point of not less than 250 M.V.A. H.V. switchgear over 150 M.V.A. rating is preferably spring or solenoid closed and where the rating is 250 M.V.A. or over the master control should be installed some distance away from the switchgear. Where for any reason the controlling switchgear is of a lower rating than the fault level, reactors, may under suitable conditions, be used to limit the fault current. The added reactance does, however, increase the regulation i.e. the difference between the voltage on no load and on full load, it being borne in mind that the regulation becomes worse as the power factor is reduced. In general the greater the reduction in fault level required, the larger the normal full load, and the lower the power factor the larger will be the reactor and the worse the regulation.

Table 2.4

Relation between added Reactance in percent and percent increase in Regulation at various power factors

Added % Reactance	Regulation % increase		
	$\cos\theta = 1$	$\cos\theta = .9$	$\cos\theta = .8$
1	—	.4	.5
2	—	.75	1.15
3	—	1.25	1.75
4	.1	1.6	2.4
5	.15	2.2	3.0
6	.2	2.7	3.75
7	.25	3.2	4.5
8	.3	3.75	5.15
9	.4	4.3	5.8
10	.5	5.0	6.0

As an example an installation served at 11000 volts and having a normal full load of 6,000 K.V.A. would require a reactor of .805 ohms in order to limit the fault level to 150 M.V.A. i.e.

$$I_s = \frac{150 \times 10^6}{\sqrt{3} \times 11000} = 7880 \text{ amperes per phase.}$$

See Table 2.3 where I_s is the symmetrical fault current per phase. thus the impedance, or reactance in view of small value of the resistance component, is $\frac{6350}{7880} = .805$ ohms. The full load current in respect of 6,000 K.V.A. is 315 amperes and the voltage drop (total) across the reactor on full load is $.805 \times 315 = 252$ volts or 2.29% therefore from Table 2.4 the regulation increase is nil at unity power factor ($\cos\theta = 1$), approximately 1% at 90% ($\cos\theta = .9$) and 1.45% at 80% ($\cos\theta = .8$) power factor.

If, however, the rupturing capacity of the switchgear is to be limited to 75 M.V.A. the reactor reactance is 1.61 ohms, the reactor

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Ore, Coal and Grain Handling Plant at Iskenderun, Turkey (Part II.)

By Dipl.-Ing. HERMANN DIETRICH
(Chief Engineer, Kampnagel A.G.)

IN a previous article a description was given of the plans for extending the port facilities of Iskenderun (formerly Alexandrette) and of the grain handling plant built there. This second article gives a brief survey of Turkey's mineral resources and mining industry, followed by a description of the ore and coal handling installations, which have meanwhile been put into service.

Turkey's Mineral Resources and Mining Industry.

Turkey has long been noted for its rich and varied mineral resources. Over four thousand years ago the mining and working of copper, lead, silver, gold and precious stones already played an important part in Anatolia, and from about 1800 B.C. onward iron was mined and used for making implements and other objects. The Hittites, Persians, Greeks and Romans, as well as their Byzantine and Ottoman successors, were all keenly interested in mining.

It was only during the previous century, however, that the discovery and exploitation of extensive deposits of coal and lignite, as well as of chromium and manganese ores, brought about a vigorous and continued development of communications and industrial potentialities. But it was not until the abolition of the sultanate by Mustafa Kemal Pasha in the nineteen-twenties that the development of the mining industry with government funds was methodically taken in hand. The entire coal, copper and sulphur mining industry as well as the greater part of the country's brown coal production and the exploitation of several other ore deposits are now State-owned industries. In 1935 the Turkish government, with admirable foresight, established a Mineral Research and Exploration Institute (M.T.A.E.) at Ankara. With the assistance of foreign experts, this Institute is conducting a systematic investigation of utilisable mineral deposits with regard to their size and suitability for exploitation; a geological survey is also being carried out. The introduction of a new Mining Act facilitates the participation of foreign capital in Turkish mining enterprises.

By increasing the number of mines and rationalising the mining industry it has been possible to step up the output of chromium ore to about 200,000 tons and that of manganese ore to about 80,000 tons per year. In the southern part of the country fresh iron ore deposits have been opened up. Turkey has thus succeeded in becoming an important producer and exporter on the mineral markets of the world, as will be apparent from Fig. 1, which shows the trend of Turkish mining output over the period 1900—1953.

In this connection it should be mentioned that the hundreds of mineral deposits found in Turkey moreover yield many other valuable products — as yet mainly for home consumption — such as molybdenum, vanadium, antimony, arsenic, mercury, bauxite, asbestos, emery, alunite, common salt, asphalt, petroleum and other minerals; these have not yet been anything like fully explored or developed.

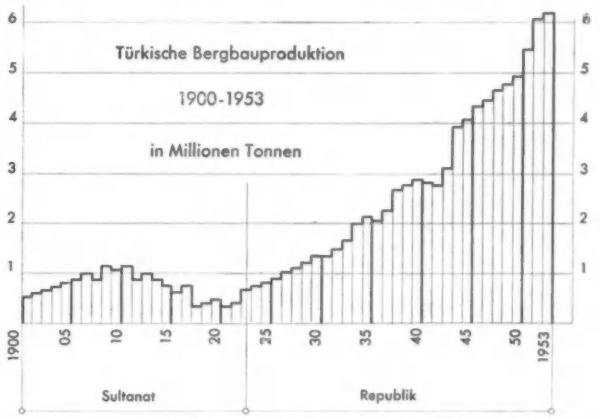


Fig. 1. Turkish mining production 1900-1953 (millions of tons).

Extension of the Port Facilities of Iskenderun.

It is obvious that the Turkish government, in addition to building its own ore smelting plants and the requisite power stations, had to carry out an extensive programme of railway and road construction and of enlarging the capacity of the transit ports, in order to provide export facilities for the steadily increasing output of mineral products. One of the most important new installations that has been constructed within the framework of this development programme—which is receiving generous financial support from the International Bank for Reconstruction and Development —is the combined bulk handling plant that has now been completed at the port of Iskenderun on the Eastern Mediterranean. The general plan of this plant and the first portion of it to be constructed, namely, the grain handling plant, have already been described in the September 1956 number of this Journal. As has already been pointed out in the previous article, Iskenderun is favourably situated not only in relation to the Cilician corn-producing region but also in relation to the principal ore deposits in the Anti-Taurus district. For this port the most economical solution was thus found to consist in a combined handling plant for grain, ore and coal, and for this purpose a bridge carrying belt conveyor for each of these three commodities has been constructed on an existing jetty. Fig. 2 shows a cross-section through this bridge structure with its three conveyors, separated by partitions, and its loading towers: for grain on the left, and for ore on the

Electrical Distribution as applied to Docks

voltage drop 4.5% and the corresponding regulation increases 1.02%, 2.0% and 2.7% respectively.

Note—(The reactance of the supply system neglected.) The constructional details of a reactor for dock installation are similar to that of a transformer except there is no secondary winding, the reactor thus being comprised of a laminated iron core provided with a winding which is in series with the circuit in which current limitation is required. For the purpose of insulation and cooling the reactor is immersed in a tank filled with transformer oil. Reactors are rated in terms of the voltage drop as a percentage of system voltage thus a 5% reactor on a 11,000 volt system will have a voltage drop per phase of

$$\frac{11000}{\sqrt{3}} \times \frac{5}{100} = 63.5 \times 5 = 317.5 \text{ volts per phase,}$$

and the continuous rating, if the full load current is say 315 amperes (i.e. a 3 phase load of 6,000 K.V.A. at 11,000 volts) is $\frac{315 \times 317.5}{1000} \times 3 = 100 \times 3 = 300$ K.V.A. This reactor will allow a maximum of 20× full load current to pass and in order that the reactance shall not be reduced under these conditions the magnetic system (i.e. the iron core) must not become saturated and it is necessary therefore to design the magnetic system for a low flux density, and as an additional safeguard, an air gap is often included.

The losses in reactors are due to the copper losses in the winding and the iron losses in the core and may be taken as in the order of 5% of the K.V.A. rating of the reactor.

On dock systems a reactor, if used, is usually connected between the incoming supply and the Dock Authority's main switchboard.

(To be continued)

Ore, Coal and Grain Handling Plant—continued

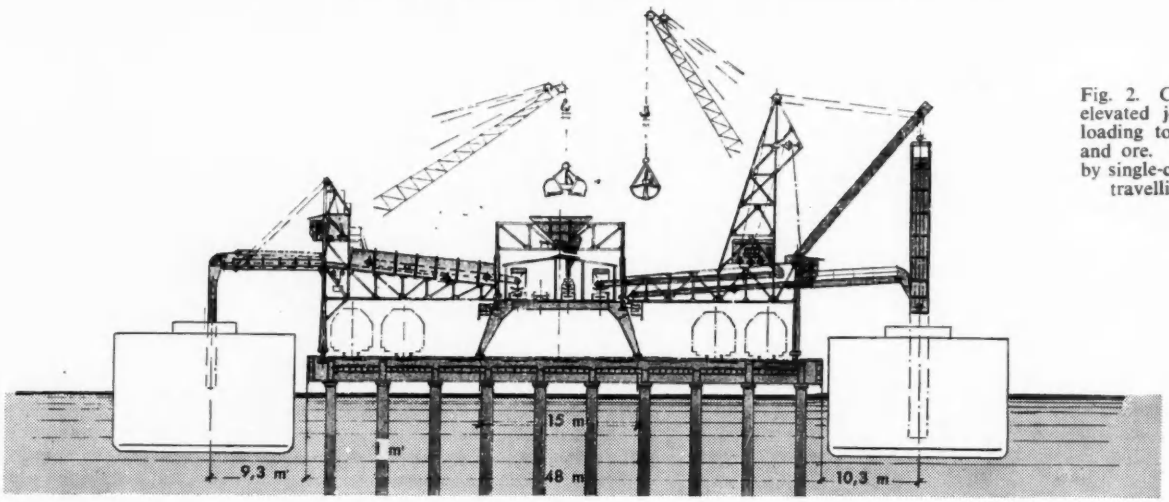


Fig. 2. Cross-section of elevated jetty head with loading towers for grain and ore. Coal is loaded by single-chain grabs into travelling hoppers.

right. Between these two is the coal conveyor, which will be further described below.

The Ore Handling Plant.

The ore conveyor with a handling capacity of 250 tons/hour occupies an approximately symmetrical position in relation to the grain handling plant, the latter being designed for a normal capacity of 300 tons/hour, subsequently to be increased to 600 tons/hour. Like the grain conveyor, the ore handling conveyor incorporates rubber belts 800 mm. in width. Since most of the ores to be handled consist of large angular lumps, the conveyor speed is limited to 1.05 m/sec. in order to avoid excessive wear and tear of the belts. By means of four successive conveyor belts the ore is transported a total distance of about 900 m. (subsequently 1150 m.) from the storage area to the jetty head, where, with the aid of a throw-off carriage which can travel over a length of 160 m., it is fed to the travelling ore loading tower (Fig. 3).

This tower had to be very carefully designed because, on the one hand, it had to be suitable for loading vessels of widely differing sizes and, on the other hand, its wheel loads on the quayside rail had to be kept down to a very low value on account of the limited strength of the existing jetty structure. This loading device has an A-shaped derrick type jib about 20 m. in length from which is suspended a vertical downward conveyor for " gently " discharging friable ores into the vessel. By means of hoisting machinery this vertical conveyor can be raised or lowered to any desired height so as to adapt it to different sizes of vessels. The detachable transfer chute connecting the discharge end of the horizontally extendable belt conveyor with the vertical conveyor must obviously have a sliding attachment to the latter in order to enable the material to be fed in at any desired level. The vertical downward conveyor is driven by an electric motor equipped with pole-changing control, which permits a 33 per cent. increase in conveyor speed in the event of the conveyor being overloaded for a limited period. In addition, the drive is provided with an overload release which stops the conveyor and thus prevents damage occurring if foreign bodies such as drill tools, pickaxes, shovels, etc. should happen to be present in the material handled.

The loading tower is controlled from an elevated operator's cabin provided with windows giving an unrestricted view and thus facilitating accurate control and supervision of the loading operation. All manipulations for moving the tower into position are regulated and interlinked by means of limit switches and electric locking devices so as virtually to preclude any risk of wrong operation of the plant due to negligence. The tower operator receives his instructions to start and stop loading by telephone from the central control point and can, in turn, give instructions as to starting and stopping the transport of ore from the storage area.

The belt conveyor running alongside the ore storage area is fed by two or three transporter cranes equipped with 8-ton grab trolleys. The ore taken from the storage area is dumped into discharge hoppers which are structurally connected to the transporters. The ore is fed continuously on to the belt by means of variable-speed apron conveyors (Fig. 4).

The ore is delivered to the storage area by rail, initially in open goods wagons of widely varying size; subsequently, however, special wagons with automatic discharge gear will be employed. In order to deal quickly with ore trains, a 190 m. long sunken bunker of approximately 5,000 tons capacity and capable of holding several trainloads of ore has been constructed between the two supply tracks.

Wagons with removable side panels can conveniently be emptied

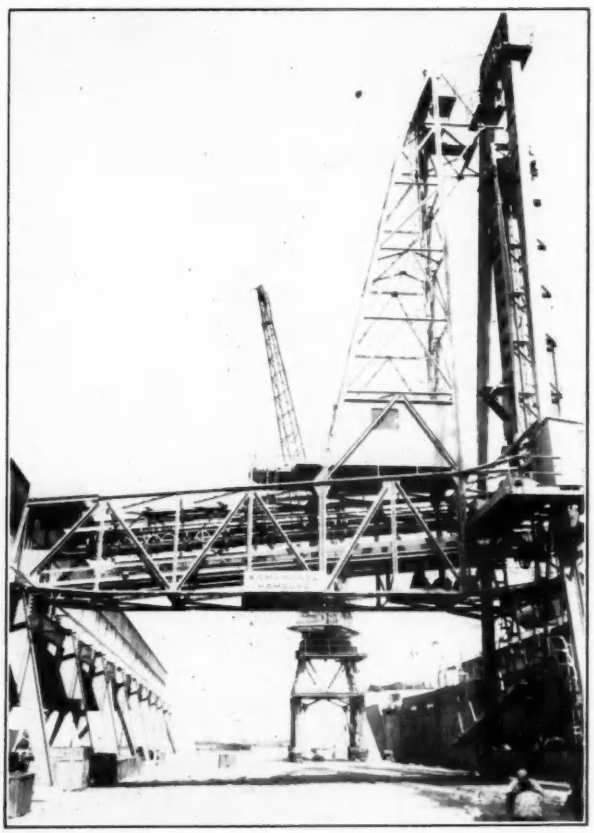


Fig. 3. Travelling ore loading tower with vertical downward conveyor.

Ore, Coal and Grain Handling Plant—continued

laterally into the bunker with the aid of ordinary 1.3 m.³ grabs with smooth edges. For unloading smaller box-type wagons with fixed sides, three grabs of 0.75 m.³ capacity are available. For removing the ore from the bunker and stacking it on the storage area, graded according to type, there are three large 1.6 m.³ trimming grabs fitted with teeth for dealing with crude ore consisting of large lumps and two ordinary grabs without teeth for handling fine-grained heavy ore concentrates. Despite the poor grabbing properties of the heavy lumps of ore, the requisite average handling rate of 125 tons/hour per transporter trolley is attained by means of the trimming grabs. The different types of grab are easily interchangeable. The drums operating the jaw-closing mechanism of the grabs are provided with pockets for accommodating the wire rope couplers.

The hoisting mechanism of the grabs is provided with fully automatic contactor equipment with time control devices which prevent it being switched too rapidly to top speed. The trolley drives are equipped with limit stop switching and automatic motor speed control devices limiting the speed of the trolley on the end portions of its track. By this means the full track length is utilised without risk of the trolley reaching its end position at full speed. In addition, heavily sprung buffers serve to prevent the occurrence of severe impact vibrations. All hoisting movements are, of course, also safeguarded by limit switches in order to preclude damage arising from negligence.

A fourth trolley is provided as a standby in the event of technical disorders. This reserve trolley is kept permanently in readiness in a "repair tower" installed to one side of the area served by the gantries. A trolley in need of repair is run into a side compartment of this tower. With the aid of switch rails and a trailing cable this operation can be controlled from the crane driver's cabin. By means of this trailing cable the transporters can also be moved along to the adjacent bay for taking on the reserve trolley. Like the driving machinery for the belt conveyors, which has previously been described, the entire electrical equipment of the cranes has been designed for tropical conditions with an ambient temperature of 50° C.

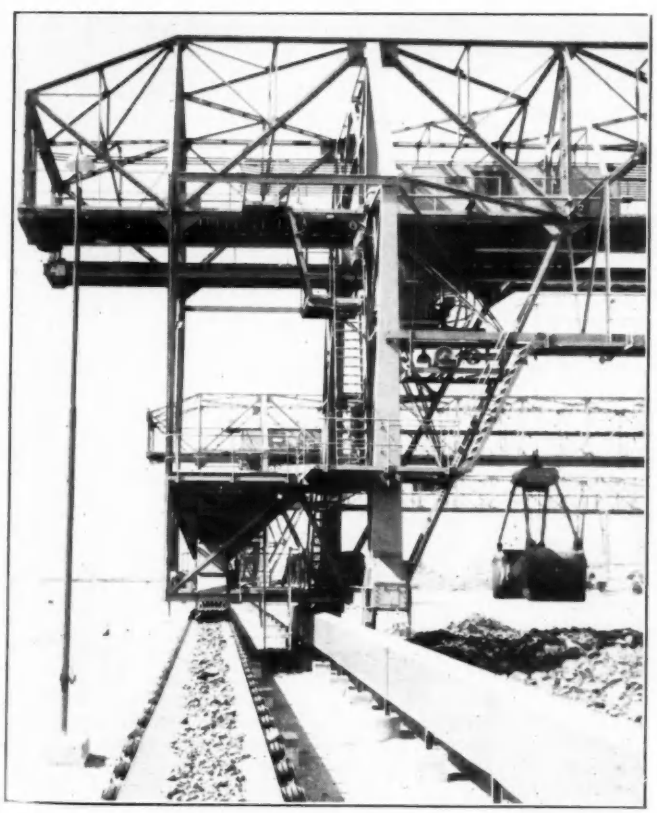


Fig. 4. The ore is picked up by the grabs of the three transporter cranes, passed through intermediate bins and carried by belt conveyors to the jetty head.

Fig. 5. Transporter over coal storage area, with suspended belt conveyor and reversible belt for evenly stacking the coal.

The Coal Handling Plant.

The front portion of the storage area served by the three transporter cranes is intended for the storage of coal, which is brought in by sea-going ships—chiefly from Turkish ports on the Black Sea—and distributed for home consumption (railways, factories and domestic use) in the provinces around Iskenderun. For unloading the coal the existing 6-ton level luffing cranes on each side of the jetty were equipped with new 2.5 m.³ grabs suspended from crane hooks. The coal is dumped into travelling discharge hoppers, of 20 tons capacity each, which are mounted on the bridge structure carrying the belt conveyors and can be moved along to suitable positions in relation to the hatches of the vessel being unloaded. At intervals of approximately 10 m. the roof over the conveyor bridge is provided with hatchways having sliding covers. The coal is fed continuously from the hoppers through these hatchways on to the central belt conveyor situated beneath them (see Fig. 2). Initially the two coal hoppers are being used only over a length of about 40 m. on the rear portion of the jetty head. As this restricts the operating range of the loading towers for grain and ore, however, it is intended to widen the narrow stem of the jetty as soon as possible to the full width of the jetty head (approximately 48 m.) and also to increase the depth of water alongside, so as to enable coal ships to be moored here in the future. The abovementioned coal hoppers will then be moved to this part of the jetty, for which the necessary arrangements have already been made, the tracks 150 m. in length and the requisite thirteen roof hatchways having been constructed at this stage.

The coal conveyor belts are 650 mm. in width and have a handling capacity of 200 tons/hour at a belt speed of 2.0 m./sec. This capacity can, however, be fully utilised if a coal ship is being unloaded on each side of the jetty, with two grab cranes per ship. It is intended subsequently to provide level luffing grab cranes of greater capacity, as the existing single-rope cranes are really only suitable for general cargo handling.

At the shore end of the conveyor bridge the coal is transferred on to a transverse overhead belt conveyor running alongside the coal storage area for a distance of about 130 m. By means of a throw-off carriage this conveyor can either deliver the coal directly into railway wagons standing on two parallel sidings or transfer it to a transporter. As shown in Fig. 5 this transporter has a fixed as well as a movable and reversible belt conveyor by means of which the coal can—if there are no empty wagons waiting to be loaded—be stacked over the full width of the storage area, without any need for trimming. Rehandling the coal for loading it into railway wagons or lorries is effected by means of the grab trolley, which for this purpose is equipped with a 2.5 m.³ grab.

Ore, Coal and Grain Handling Plant—continued

The above-mentioned throw-off carriage is remarkable not only on account of its discharge chute capable of being easily and quickly switched from one wagon to the next, but also on account of its independent propelling mechanism, which is automatically disconnected when the carriage is coupled to the transporter. All operational movement of the throw-off carriage are indicated by control desk, who has the task of simultaneously controlling all three conveyors, the loading of ore requires only two or three crane drivers, a man on the loading tower, and a machine minder whose job is to supervise the proper running of the conveyor belts. For coal handling only one or two additional men are necessary; and for grain handling two more machine attendants are likewise all

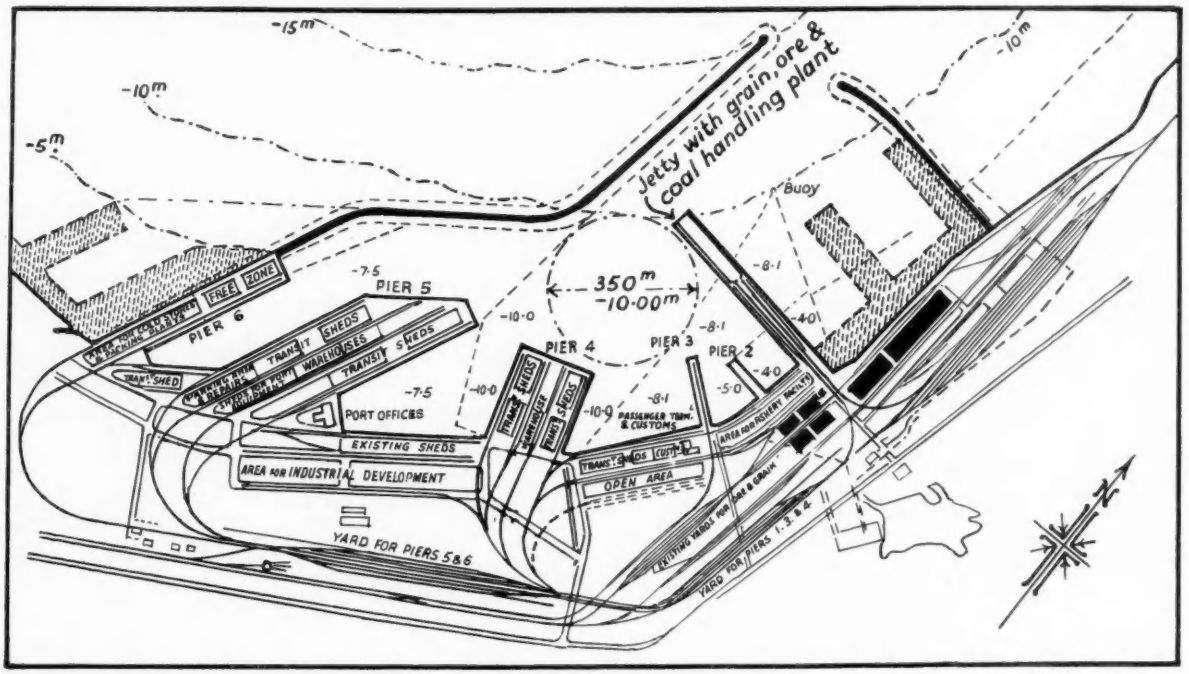


Fig. 6. The anticipated increase in the volume of cargo handled by the port of Iskenderun calls for the provision of more harbour basins and the construction of a breakwater.

means of pilot contact wires in conjunction with illuminated signals at the central control desk in the operator's cabin. Like the ore and grain handling plant, the coal handling plant is equipped with an automatic conveyor weight meter, which permits a check to be kept on the rate of delivery at any given time as well as on overall conveyor performance.

All rubber belting is of tropical quality, specially resistant to intensive ultra-violet radiation. In view of the very severe storms, with wind velocities up to 60 m./sec., which occur at Iskenderun, all unprotected belt conveyors had to be secured against lifting effects.

Electrical Installations.

The whole new handling plant is supplied with 380-volt three-phase current by an existing diesel power station in the harbour area. A systematically sub-divided feed cable layout with numerous distributing points ensures continued operation of the plant in the event of a partial breakdown. Provision has been made for a possible future extension of the connections. For further technical details of the electrical equipment and its function, the reader is referred to the description of the grain handling plant in the previous article. The whole plant is, of course, also equipped with adequate lighting for uninterrupted three-shift operation; power and light plug boxes for carrying out repairs are furthermore provided in sufficient number. An automatic telephone system with fifteen extensions and an exchange connection, potentially capable of serving 25 users, ensures ease of control and supervision of the handling installations, which are spread out over a very large area. A large number of plug-in points are provided for use with portable telephone equipment when carrying out repairs to the plant.

By concentrating all the electrical control gear in one central control station on the jetty head the advantage is obtained that only a very small number of attendants are needed for operating the combined handling plant. Besides the operator at the central that are needed. This clearly shows the economic advantages of continuous bulk handling by means of rubber belt conveyors.

Auxiliary Plant.

For shunting the ore and coal wagons on to the sidings running alongside the storage area an electric capstan windlass with several return pulleys is provided. For the rapid weighing of incoming and outgoing wagons an 80-ton railway track scale of the non-relieved type, fitted with illuminated indicator and ticket-printing device, is installed in a suitable location.

For all minor loading jobs in the storage yard a conveniently manoeuvrable mobile crane has been provided, which is moreover equipped with a clearing blade for scaping together residual material into heaps. With its heavy-duty hook and tackle this mobile crane can furthermore be used for other transport and erection purposes throughout the port installations.

Future Port Extension Scheme.

Iskenderun is a vigorously growing town. The number of its inhabitants has, in recent years, risen by leaps and bounds to about 30,000, as there are, in addition to the port installations, some industrial establishments which offer suitable employment. The possibility of Iskenderun becoming increasingly important as an oil import and export harbour has latterly come to the fore. Fig. 6, depicting the projected extension, shows what form the future development of this port is expected to take. Besides the bulk handling plant constructed on the existing jetty, the narrow stern of which is to be widened as soon as possible, the scheme provides for the construction of some modern piers with berthing accommodation on two sides and mechanical equipment to cope with the increasing volume of general cargo traffic. Breakwaters will protect the harbour basin from the prevailing strong west winds. The fact that, along with some other countries, the German Federal Republic has recently established a consulate at Iskenderun indicates how important a place this is considered to be.

Litigation in the Port Industry

Some Recent Legal Decisions

By LAWRENCE WEBLEY, LL.B.

Cargo Stowage Safety Precautions.

Regulation 41 of the Docks Regulations 1934 provides that "where stacking, unstacking, stowing or unstowing of cargo or handling in connection therewith cannot be safely carried out unaided, reasonable measures to guard against accident shall be taken by shoring or otherwise." The meaning and effect of this regulation has recently been considered by the High Court in a case where a docker fell off a stack of barrels in a ship's hold and alleged, in the subsequent legal action, that the shipowners and the P.L.A. were in breach of it, "Jeyes v. Currie Line Ltd. and Port of London Authority."

The accident happened when the No. 2 hold of the Currie line motor vessel "Scotland" was being unloaded. The hold contained potatoes on top. In the lower hold one-third of the space was filled with barrels of lemon peel which stretched from the port side to the starboard side. These barrels were about 3-ft. in diameter, 4-ft. long and weighed approximately half a ton each. There were 6/7 rows of them and each row contained about 15 barrels. They were stacked three tiers high. In front and flush up against them were cases of pulp resting on top of bare pieces of marble which were laid on the ceiling of the ship. The barrels were, in general, stowed booge and cutlet, i.e. the bellies of the upper tier rested in the hollows formed at the meeting of the sloping ends of the barrels beneath, the top row being pushed back half a length and all the barrels being laid fore and aft. Apparently, however, some of the barrels in the upper tier overlapped those below. The ganger in charge of the work in the hold told the ship's clerk that some of the barrels were stowed in an unusual fashion but he did not consider they were dangerous and took no special precautions. The injured docker had the job of receiving the hooks which were lowered into the hold to take up the barrels. While he was doing his he stepped on one of them which, apparently, tilted with the result that he fell off the stack and hurt his spine. When the mishap occurred most of the cases of pulp which had been flush up abainst the barrels had been removed.

The judge said that Regulation 41 clearly had no application to the matter. The reason for putting the words "cannot be safely carried out unaided" in that form was that it was not intended that a person should be liable to prosecution if the work was such that it could be safely carried out unaided, although shoring would be one of the ways of avoiding any trouble. The words meant what they said. The evidence made it clear that these barrels could perfectly safely be unloaded unaided by any shoring or other abnormal device if it was known that they were overstowed and if care was taken by the people handling them to see that they incurred no danger through that fact. One part of the case against the P.L.A. was that they failed to shore the barrels but, the judge continued, in his view, as he had said, the regulation did not apply.

However, the judge did not accept that the docker knew that there was some danger from the barrels. He should, he said, have been warned and the ganger had committed an error of judgment in deciding there was no danger. Accordingly, the P.L.A. was liable a Common Law. But the docker had had ample opportunity to see the position for himself and he was, the judge decided, 50 per cent. to blame for his own injuries. In consequence, the judge reduced the damages awarded against the P.L.A. by half. As to the shipowners, the judge said that merely telling the ship's clerk that the cargo was usually stowed did not make them liable. They had no reason to suppose the cargo was dangerously stowed and the case against them would be dismissed. The judge ordered that four-fifths of the shipowners' costs should be paid by the P.L.A. as, in the circumstances, it was not unreasonable for the plaintiff to sue the shipowners as well. Much legal expense had, however, been incurred in a relatively small matter and the remaining fifth should be paid by the plaintiff.

It is not easy to understand here how the plaintiff could have been unaware that some of the barrels were overstowed and might tip. The case merely serves to emphasise the need for giving definite warning of dangers even when they should be obvious. In fact, this accident might had had far more serious consequences as, apparently, the falling half-ton barrel narrowly missed the injured man. As for the regulation, the judge's remarks appear to indicate that shoring is only necessary when the lack of it would be a definite danger in spite of the men taking reasonable care.

Ship to Shore Access Dispute.

Regulation 9 which deals with access has also just recently received the attention of the Courts. Early last year a firm of master stevedores were unloading a cargo of timber from the s.s. "Torun" at Canada Dock, Surrey Commercial Docks. The "Torun" was lying alongside a dumb barge which was between her and the quay to which she was moored. When the unloading started the ship provided a gangway for purposes of access. However, this gangway became fractured and unsafe while the unloading was going on so it was taken away, and a wooden 20-in. wide ladder was substituted. A factory inspector who happened to visit the ship when the ladder was in position issued a summons against the firm for being in breach of Reg. 9 of the Docks Regulations and they were convicted by the magistrates; "Walter Wilson & Son Ltd. v. Summerfield." The firm appealed to the Divisional Court.

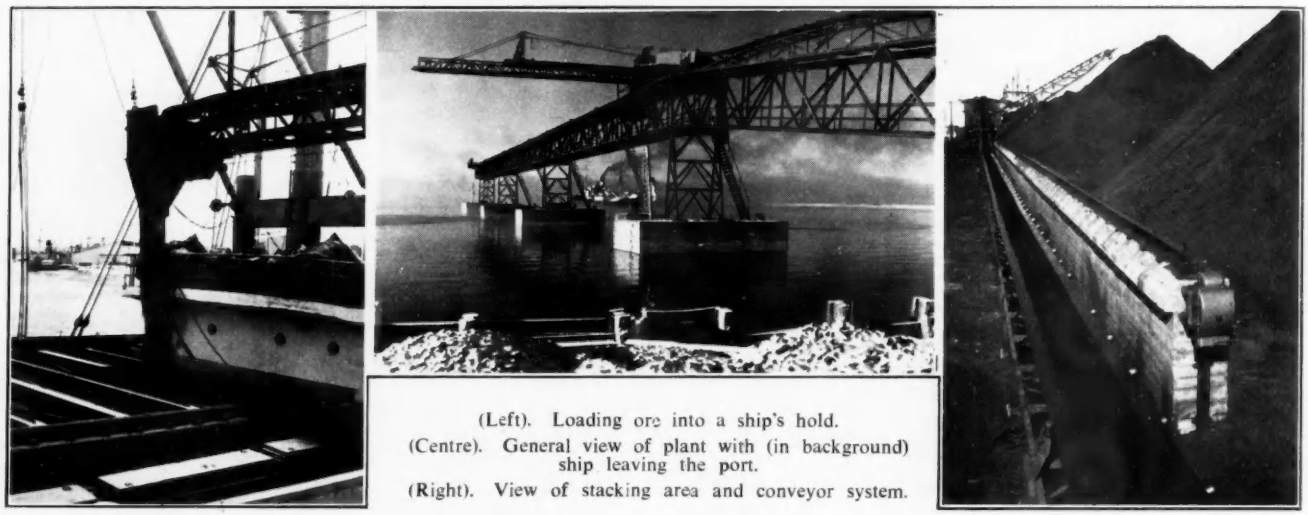
The Lord Chief Justice said that Reg. 9 was for the protection of dockers and stevedores when loading or unloading. It provided that if a ship was lying at a wharf or quay for that purpose, or for coaling, there must be a safe means of access for the people employed to go to and from ship to shore and shore to ship. The ship's accommodation ladder or a gangway had to be provided where reasonably practicable, and in other cases a ladder of sound construction properly secured. Regulation 50 provided that if the persons whose duty it was did not comply with Reg. 9 then the employers of the dockers or stevedores using the access had to do so. In spite of the presence of the dumb barge, this ship was lying at a quay for unloading and Reg. 9 applied. The primary duty to provide an accommodation ladder or gangway was on the ship; a ladder was only to be used if their provision was not reasonably practicable. The ship was in default and so the stevedores should have stepped in. The stevedores, consequently, had the task of showing that it was not reasonably practicable for them to use a gangway or accommodation ladder and the court did not accept their argument that the prosecutor first had to prove that a gangway or accommodation ladder was available to them. It was for the defendants to prove that they were not and this they had not done. The court did not see how anyone could prove that it was not reasonably practicable for a gangway or accommodation ladder to be used except the defendants, though it was true there might be a case where the inspector could say there was a gangway lying on the quay and, of course, there would be no answer to that. Accordingly, the appeal against conviction was dismissed. It seems hardly likely that an attempt of this kind to shift the onus of proof would ever have stood any chance of success and the Lord Chief Justice's remarks also dispose of the possibility of successfully raising a technical objection such as the ship not being actually alongside the quay.

Baltic Conference General Meeting.

This year's general meeting of the Baltic and International Maritime Conference is to be held in Paris from May 20 to 24. About 500 delegates from the principal maritime countries are expected to attend, and the total tonnage now represented in the Conference is 22½ million tons gross.

There will be meetings of the sub-committees; the documentary council, and of the executive committee, foilowed by open meetings at which the following lectures will be delivered: "The Phosphate deposits in North Africa, how they are utilised and how the raw phosphate is shipped to the importing countries," "Shipping and the River Plate grain trade," "The search for oil" and "The shipment of oil by sea."

A special programme of entertainments is also being planned for members and their ladies. The conference will end with the customary Banquet, to be held on Friday, May 24.



(Left). Loading ore into a ship's hold.
(Centre). General view of plant with (in background) ship leaving the port.
(Right). View of stacking area and conveyor system.

Ore Harbour at Oulu, Finland

By VILHO PIHKANEN (Shipping Manager)

When it was first decided to export iron ore from the Otanmäki Oy mine, it was necessary to choose a port the shortest distance possible from the mine and one capable of handling bulk ore cargoes. Toppila, the old harbour in Oulu proved to be the nearest shipping point to Otanmäki by rail, but it had neither the depth of water nor the handling capacity to meeet the requirements of the mine, the output from which had to be shipped during a relatively short season. It was therefore decided to build a modern, fully mechanised loading pier in the new south port of Oulu, owned and managed by the mining Company.

This new ore harbour was completed in November, 1953, and is the only port in Finland which handles exclusively the exportation of ore. The entrance channel from the outer roadstead to the berth is approximately 2,100 m. long and 80 m. wide with a maximum draught of 21-ft. in normal circumstances. Unfortunately, this channel is narrow and still without lights which often means that vessels have to wait until daylight before entering or departing.

The harbour has a guaranteed loading capacity of 1,500 tons per day in good weather and the normal working hours are 7 a.m. to 4 p.m., although overtime shifts can be arranged. With this assistance, a vessel loading about 3,000 tons can commence loading in the forenoon and leave the harbour by evening. The largest ship to use the installation so far has taken on a cargo of nearly 6,000 tons.

The ore concentrates are forwarded from the mine to the harbour in specially constructed railway wagons, equipped with tipping buckets. On reaching the export terminus, the ore is thrown onto a discharging hopper by the buckets and thence passed, by means of a belt conveyor system, either direct to the ship or to a stockyard in the harbour area which has been specially set aside for the purpose. There is sufficient space in this yard to store between 80,000 to 90,000 tons of ore. (See illustrations).

As a general rule, it is arranged that loading takes place simultaneously from the store and railway wagons, when the loading capacity of the belts may amount to between 700—800 tons per hour.

An analysis of the tonnages handled during recent years is shown in the following table.

Year	First Ship	Last Ship	Total Quantity Loaded
1953	24.11	23.12	5,600 tons
1954	12.5	12.12	166,500 ,,
1955	4.6	8.12	297,200 ,,
1956	7.6	—	203,000 ,, up to 31/8/56

It is estimated that during the current season the total quantity of ore loaded will amount to about 370,000 tons.

Generally the harbour is open from about the 20th May until 15th December. It is to be noted, however, that loading and especially the forwarding of the ore from the mine is to some degree hampered by the season of cold weather which normally begins at the end of November. During the severe winter, traffic in the port is assisted by the use of an ice-breaker.

The ore concentrates handled by the installation are magnetite, ilmenite and zinc. All these have proved to be stable cargoes and little shifting has been noticed in the ships' holds. The ore is exported to Sweden, East Germany, West Germany, Holland, Great Britain, Belgium and Italy.

The ore harbour was planned by Professor Kauko Järvinen, the technical expert of Otanmäki Oy. There is a shipping office established at the harbour to attend to the inwards and outwards clearance of vessels loading there.

Obituary

Mr. Harold John Frederick Gourley, President of the Institution of Civil Engineers

We regret to announce the death of Mr. Harold John Frederick Gourley, senior partner of Messrs. Binnie Deacon & Gourley, Consulting Engineers, who died on the 18th December last, only six weeks after being elected President of the Institution of Civil Engineers.

Mr. Gourley, who was one of the world's foremost water engineers, was born in Liverpool in 1886 and educated at the Liverpool Institute before passing on to that City's University where in 1909 he graduated as B.Eng., with first-class honours. In 1910 he became a pupil in the firm of Sir Alexander Binnie Deacon and Sons, and apart from service during the 1914-18 war, remained with the same firm all his life. In 1935 the firm was renamed Binnie, Deacon and Gourley and he became senior partner in 1949.

During the course of his work Mr. Gourley travelled throughout the world. He was largely responsible for the Hong Kong Government's Gorge Dam which was of novel construction and is probably the highest dam in the British Empire. He was presented to Her Majesty the Queen in 1955 on completion of the Usk Dam for Swansea Corporation, and again last autumn on completion of the Daer Dam which will be the main source of water supply for the people of Lanarkshire.

After the epidemic of typhoid at Croydon Mr. Gourley was appointed in 1937 one of two Technical Assessors. He was a witness for 57 undertakings at the 1947 Greater London Inquiry, on London's water supply, while in March, 1949, he was a member of the panel of 4 which inspected and reported in the Kariba and Kafue Hydro-Electric Projects.

In the Academic field Mr. Gourley won two Miller prizes, and has also been awarded two Telford Premiums for papers on water supply. In 1935 he was President of the Institution of Water Engineers, and in 1942 Chairman of the Association of Consulting Engineers.

Manufacturers' Announcements

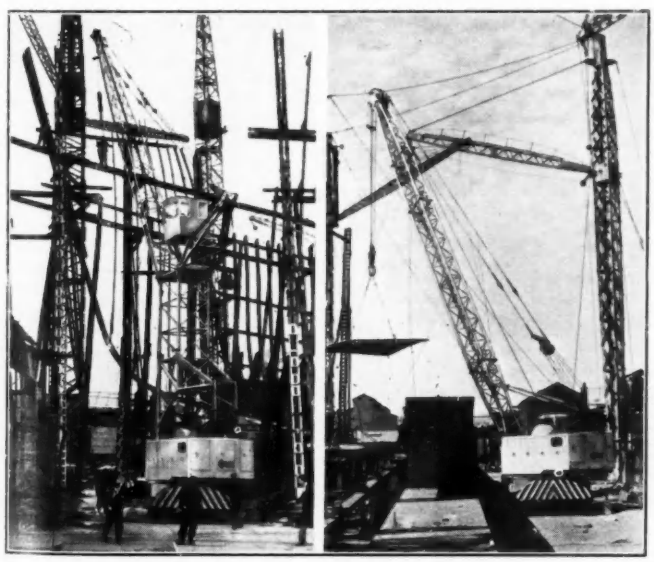
Mobile Tower Crane for Ship Construction

A recent innovation in the Shipbuilding Industry is the introduction of the Coles Mobile Tower Crane for ship construction. This machine, which is designed, manufactured and marketed by Steels Engineering Products Ltd., Sunderland, effectively combines the advantages of mobility, flexibility and manoeuvrability in small spaces, with long outreach, good clearance height and excellent driver visibility.

Three salient facts arise from the mobility of this machine. Firstly, by augmenting existing craneage in the yard, it helps to reduce the time taken for construction of a vessel, and secondly, it is able to complete fore and aft ends of a ship, which may be outside the range of normal static craneage, thus enabling a much larger ship to be built on a berth than that for which it was originally designed. Thirdly, as a strut jib crane (conversion can be carried out in 58 minutes) it is possible to erect a ramp leading from the building berth onto the tank tops of the vessel. This ramp can be used by the crane to reach the inside of the vessel where it can handle frames, shell plating and bulkheads, retreating as each stage is completed.

The crane is electrically operated but generates its own power by means of a diesel or petrol engine which makes it completely independent of trailing cables and power points, just as it is also independent of rail tracks. All four crane motions—travel, hoist, slew and derrick—are individually powered by separate electric motors which are energised by direct current from a specially designed variable speed generator coupled to the prime mover. The maximum lifting capacity is 5 tons with 30-ft. jib.

The tower is 30-ft. above ground level and the operator is thus provided with a clear view of the full working area. Raising and lowering the tower is performed by the crane itself, thus facilitating travel under bridges, overhead wires, etc. When headroom permits the crane can travel with the tower erect. The motions of the hoist, derrick and slew may be controlled from the cockpit on the superstructure or from the tower, but the travel motion is always controlled from the cockpit on the superstructure.



(Left) Coles Mobile Tower Crane assisting in the building of a cargo ship in a West Hartlepools shipyard, and (right) working as a strut jib crane.

The crane is full circle slewing in either direction without limit and many safety devices are incorporated in the system. These include, automatic limit switches to protect the machine and load should attempts be made to hoist and derrick beyond the permitted limits; electro-mechanical brakes which are automatically applied to hoist, derrick, and slew motions should the supply of current be interrupted either accidentally or intentionally; and dynamic braking to protect the motors and load against excessive lowering speeds.

Timber Doors for Dockside Shed

One hundred and twelve sliding doors, each weighing 21½ cwt., are being installed by J. Gerrard & Sons Ltd., of Swinton in the five hundred yards long shed at Alexandra Branch Dock No. 1, Liverpool, for the Mersey Docks and Harbour Board. As announced in the April, 1956, issue of this Journal, timber was also chosen for the 88-ft. span roof trusses in the reconstruction of this building which is now nearing completion.

Interior view of Shed showing new doors.

Manufactured by Messrs. William Thornton & Sons Ltd., of Liverpool, the doors are in two sizes; eighty are 23-ft. 10-in. high by 15-ft. 4-in. wide, the remaining thirty-two are 21-ft. 10-in. high by 10-ft. 6-in. wide.

The framing of Honduras pitch pine, morticed, tenoned and bolted together, is set in red lead, while the infilling is of Archangel whitewood, T & G boards of 1-in. nominal thickness.

This type of door has been used by the Mersey Docks and Harbour Board for many years, and has proved without equal, in spite of hard use and occasional damage by quayside transport, exposure to westerly gales and salt laden air.

One of the advantages claimed for the special construction is that should the boarding or framing be damaged by trucks or cargo slings, the boards can be replaced with stock T & G timber, and the stiles and rails are simply dismantled by removing the bolts and replacing the damaged component.

The doors extend for some five hundred yards, giving open access to the sheds along the whole length of the quay. This facilitates the efficient and speedy movement of cargo in transit.

Another interesting feature is that it is quite impossible for the doors to be accidentally lifted from the rails in which they run, thus ensuring the safety of the men working in the area. In spite of the heavy weight of each door, very little effort is required to operate them.

A further one-hundred-and-eighteen doors to similar specifications have been manufactured by Messrs. William Thornton & Sons Ltd., for the new Huskisson Dock Sheds.

New Plastic Hose

The problem of conveying, by hose, fresh drinking water and other potable liquids from shore installations to ship, is one faced by nearly every shipping and harbour authority. In the past, the hoses used for this work have often proved inadequate—the open texture of unlined hoses permitting the entry of dirt and other impurities found in all dockyards, while lined hoses impart a "taste" to the liquid, require drying and draining when wet, and deteriorates in contact with oils or grease and when exposed to sunlight.

This problem is now claimed to have been solved with the introduction of an entirely new hose called "Plastidry," manufactured by British Tyre & Rubber Co. Ltd., Vincent Square, London. Consisting of an odourless and tasteless P.V.C. lining and cover fused on to an all-nylon reinforcing fabric to form a

Manufacturers' Announcements—continued

plastic mass of outstanding strength and wear-resistance, the new hose is both waterproof and water repellent. It is non-rotting, impervious to attacks of rodents, insects and fungi and will not freeze or support combustion.

Especially useful in tropical climates and Eastern waters where it will not appreciably deteriorate if left in strong sunlight, Plastidry is unaffected by oils, acids and alkalis and can be exposed for years to sea-spray or chemically-laden atmospheres without coming to harm. It will, moreover, successfully combine fire-fighting and deck washing duties.

Manufactured in 1¾-in., 2½-in., 2¾-in. and 6-in. diameters, Plastidry may be used for conveying a wide range of liquids such as beer, wine, glucose and molasses. It is very light in weight, will coil flat and can be rolled "wet" after use and stored in a damp condition without deteriorating.

Polish Order for British Tugs

A contract valued at £1,000,000 for the construction of two of the world's largest Ocean Going Diesel Tugs has been secured by Messrs. Charles Hill & Sons Ltd., of Bristol, in the face of keen Continental competition. This order obtained from the Polish Government Buying Agency is the most valuable ever to be placed in a British shipyard.

The Tugs will be of an estimated 1,350 gross tons, 215-ft. overall length, 39-ft. beam and 19-ft. depth. Each Tug will be fitted with specially strengthened bows for salvage work in Baltic waters and will be so constructed that their maximum efficiency will be maintained in either Arctic or tropical conditions. The estimated launching dates are the summer and autumn of 1958.

The contract for the marine diesels to supply the propulsion and auxiliary power to these two vessels has been awarded to the National Gas & Oil Engine Co. Ltd., Ashton-under-Lyne, a member of the Brush Group. Twin National B4AUM7 diesels with Hindmarch/MWD reverse reduction gearing developing 2,830 s.h.p. at a propeller speed of 120 r.p.m. and three National/Brush 150 k.w. sets at 600 r.p.m. will provide the propulsion and auxiliary power in each of these vessels. Auxiliary power for emergencies will be provided by a McLaren generator and compressor set.

Contract for Wharf Extension at Port Harcourt

A £3½ million contract for a wharf extension at Port Harcourt, Nigeria, has been awarded to Taylor Woodrow (West Africa) Ltd., by the Government of the Federation of Nigeria, through the Crown Agents for Oversea Governments and Administrations.

The works comprise the construction of a wharf extension, 1,550-ft. long, to provide three additional deep water berths, three-single-storey transit sheds, 350-ft. by 150-ft., a single-storey warehouse, 400-ft. by 150-ft., various store and office buildings, road and rail tracks.

The contract is due to be completed by June, 1960, although it is anticipated that two of the new berths can be brought into operation before that date. The consulting engineers are Messrs. Coode & Partners, of London.

Salvage and Supply Ship for Lake Maracaibo

Ferguson Brothers (Port Glasgow) Ltd., recently launched the single-screw salvage and supply vessel Pavo, designed and built by them to the order of the Shell Company of Venezuela for service in oil drilling operations on Lake Maracaibo. The Pavo, which has dimensions of 126-ft. by 33-ft. by 11½-ft., and is about 400 gross tons, will serve oil derricks which are built on the lake bottom. The vessel is equipped with a 30-ton derrick and 100-ton sheerlegs. She has a large clear deck space for stowage of drill piping and other oil field equipment. Electrically driven winches and capstans are fitted.

FOR SALE

HEAVY SALVAGE CRANE, Petrol/Electric operation. Will lift 60 tons at 15-ft. radius. Mounted on transporter type trailer. Full specification and price on application to VALES PLANT REGISTER LIMITED, 14, Lower Grosvenor Place, S.W.1.

APPOINTMENTS VACANT

BOMBAY (India) Firm of Civil Engineering Contractors (Danish controlled) require urgently Civil Engineer for post of Deputy Engineer-Agent on their contract for construction of a graving dock in Bombay.
Qualifications required: Civil Engineering degree, practical experience in execution of heavy civil engineering jobs especially maritime structures and harbour works.
Age 30-40 years knowledge of French language required. Remuneration depending on qualifications and experience—salary in the region of £2,000 to £4,000 per annum with bonus terms. Assistance with living accommodation. Employment in the first instance on a contract for 3 years. For the right man also possibility of permanent position with the firm.
Write with full particulars, giving at least two references, to Box No. 195, "The Dock and Harbour Authority," 19 Harcourt Street, London, W.1.

BLYTH HARBOUR COMMISSION
ASSISTANT ENGINEER

The BLYTH HARBOUR COMMISSIONERS invite applications for the position of Assistant Engineer.

Candidates should be under 45 years of age and should be Corporate Members of the Institution of Civil Engineers. They should be experienced in the engineering work of a port and conservancy authority, including the design, construction and maintenace of port installations.

The commencing salary will be determined by the age, qualifications and experience of the selected candidate but will be not less than £1,050 per annum.

The selected candidate will be required to pass a medical examination, and to join the Commissioners' contributory Superannuation Fund, to which existing pension rights may be transferred in approved cases. He will be required to reside in Blyth, and in certain circumstances assistance will be given in house purchase.

Applications stating age, professional qualifications and experience, accompanied by copies of three recent testimonials or names of persons to whom reference may be made, should be forwarded in a sealed envelope marked "Confidential" to the undersigned to be received not later than 18th February, 1957.

Harbour Office,
BLYTH, Northumberland.

G. L. ATKINSON,
General Manager and Secretary.

BRITISH TRANSPORT WATERWAYS require ENGINEERING ASSISTANT (CIVIL) at Leeds. Applicants should have good practical experience in the design, execution and maintenance of civil engineering works. Knowledge of river or marine works would be an advantage. Preference to corporate members of the Institution of Civil Engineers. Salary range £855/£900 per annum. Certain privilege rail travel facilities. Superannuation fund. Applications stating qualifications, experience and present salary, to be addressed to the Staff and Establishment Officer, 22, Dorset Square, London, N.W.1, not later than the 23rd January, 1957

PUBLIC SERVICE OF SOUTH AUSTRALIA

Applications for the undermenticned position should be made in writing to the AGENT-GENERAL FOR SOUTH AUSTRALIA, SOUTH AUSTRALIA HOUSE, MARBLE ARCH, LONDON, W.1, setting out full names, address, date of birth, marital status, academic qualifications, practical experience, and particulars of war service (if any). Copies of testimonials and a photograph should be submitted with the application.

CHIEF ENGINEER

Salary: £A3026 per annum.

Applications are invited for the position of Chief Engineer of the South Australian Harbours Board, a State Ports Authority charged with the administration, development and maintenance of the deep sea ports of Adelaide, Pirie, Wallaroo, Lincoln and Thevenard and also 50 minor outports.

Applicants should be not more than 50 years of age, holders of approved University degrees in engineering, or corporate members of the Institution of Civil Engineers, London, or Institution of Engineers, Australia, who have specialised in port and harbour engineering.

The Chief Engineer will have responsibility for an engineering organisation at present numbering approximately 100 staff and 650 other employees, undertaking the design, construction and maintenance of engineering works and port installations. These includes wharves and piers in reinforced concrete, steel and timber; retaining walls in steel sheetpiling and reinforced concrete; piled foundations, steel framed transit sheds and port buildings generally; the mechanical equipment of wharves, including electrically operated wharf cranes for general and heavy duty; electric power and lighting; major bulk coal and grain handling installations; breakwaters and earthworks. He will also be responsible for a fairly large dockyard engineering establishment; the maintenance and operation of a considerable fleet of dredgers, tugs, barges and other floating plant; the execution of major dredging and reclamation works; the installation and maintenance of aids to navigation; and the use and upkeep of a wide range of construction plant.

Administrative capacity of a high order and ability to lead and co-ordinate the work of other qualified engineers are essential qualifications.

The Chief Engineer is directly responsible to the General Manager, who is due to retire in March, 1961.